MASS. EA10.102:M55

84-AC-1

UMASS/AMHERST
312066 0285 3428 4

MERRIMACK RIVER BASIN
1999 WATER QUALITY ASSESSMENT REPORT

Merrimack River From Crescent Yacht Club, Haverhill Massachusetts

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
BOB DURAND, SECRETARY
MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
LAUREN A. LISS, COMMISSIONER
BUREAU OF RESOURCE PROTECTION
CYNTHIA GILES, ASSISTANT COMMISSIONER
DIVISION OF WATERSHED MANAGEMENT
GLENN HAAS, DIRECTOR

NOTICE OF AVAILABILITY

LIMITED COPIES OF THIS REPORT ARE AVAILABLE AT NO COST BY WRITTEN REQUEST TO:

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATERSHED MANAGEMENT
627 MAIN STREET
WORCESTER, MA 01608

This report is also available from MA DEP's home page on the World Wide Web at:

http://www.state.ma.us/dep/brp/wm/wmpubs.htm

Furthermore, at the time of first printing, eight copies of each report published by this office are submitted to the State Library at the State House in Boston; these copies are subsequently distributed as follows:

- On shelf; retained at the State Library (two copies);
- Microfilmed retained at the State Library;
- Delivered to the Boston Public Library at Copley Square;
- Delivered to the Worcester Public Library;
- Delivered to the Springfield Public Library;
- Delivered to the University Library at UMass, Amherst;
- Delivered to the Library of Congress in Washington, D.C.

Moreover, this wide circulation is augmented by inter-library loans from the above-listed libraries. For example a resident in Rehoboth can apply at their local library for loan of any MA DEP DWM report from the Worcester Public Library.

A complete list of reports published since 1963 is updated annually and printed in July. This report, entitled, "Publications of the Massachusetts Division of Watershed Management – Watershed Planning Program, 1963-(current year)", is also available by writing to the DWM in Worcester.

The Merrimack River Watershed Council (MRWC), Lawrence MA, is also a repository for information and reports on the Merrimack River Basin.

DISCLAIMER

References to trade names, commercial products, manufacturers, or distributors in this report constituted neither endorsement nor recommendations by the Division of Watershed Management for use.

MERRIMACK RIVER BASIN

1999 WATER QUALITY ASSESSMENT REPORT

Prepared by:

Laurie E. Kennedy, Stella Kiras, and Richard McVoy, Ph. D.

Department of Environmental Protection
Division of Watershed Management

Report Number:

84-AC-1

DWM Control Number:

52.0

Massachusetts Department of Environmental Protection
Division of Watershed Management
Worcester, Massachusetts

November 2001

ACKNOWLEDGEMENTS

Coordination of local, state and federal agencies and private organizations is fundamental to the success of the Massachusetts Watershed Initiative. We would like to thank Bill Dunn, Executive Office of Environmental Affairs and the Merrimack River Watershed Team for facilitating that process. Data and information used in this report was provided in part by the following agencies and organizations:

State

- Department of Environmental Protection (DEP):
  - Bureau of Resource Protection
  - Bureau of Waste Prevention
  - Bureau of Waste Site Cleanup
- Massachusetts Department of Public Health (MA DPH)
- Department of Fisheries, Wildlife, and Environmental Law Enforcement (DFWELE)
  - Division of Marine Fisheries
  - Division of Fisheries and Wildlife
  - Riverways Program
- Department of Environmental Management (DEM)

Federal

- Environmental Protection Agency (EPA)
- United States Geological Survey (USGS)
  - Water Resources Division

Regional

- Merrimack River Watershed Council
- Stream Teams (in subwatersheds of the Merrimack River Basin)
  - Salmon Brook,
  - Lawrence Brook,
  - Bare Meadow Brook,
  - Cobbler Brook in Merrimac, and
  - Upper and Lower Stony Brook Subwatershed.

Much appreciation is also extended to several DEP employees for their contributions: Jim Blair, Jane Colonna-Romano, Susan Connors, Tom Dallaire, Ken Dominick, Juliet Mathers, and Arthur Screpetis.

It is impossible to thank everyone who contributed to the assessment report process: field, laboratory, data management, writing, editing, and graphics, as well as meetings, phone calls, and many e-mails. All of these contributions are very much appreciated.

Cover photo credit: Galaca Web Solutions, http://www.members.mva.net/galaca/p65cycmerrieast.html

TABLE OF CONTENTS

Table of Contents i
List of Appendices ii
List of Tables and Figures iii
List of Acronyms iv
List of Units iv
Executive Summary v
Introduction 1
Assessment Methodology 2
Merrimack River Basin Description and Classification 12
Summary of Existing Conditions and Perceived Problems 15
Objectives 18
Sources of Information 19
Total Maximum Daily Loads (TMDL) 26
Segment Report Format 27
Merrimack River Basin– River and Estuary Segment Assessments 28
- Martins Pond Brook (Segment MA84A-19) 29
- Merrimack River (Segment MA84A-01) 31
- Lawrence Brook (Segment MA84A-20) 34
- Deep Brook (Segment MA84A-21) 35
- Beaver Brook (Segment MA84B-05) 37
- Unnamed Tributary "Reedy Meadow Brook" (Segment MA84B-01) 39
- Beaver Brook (Segment MA84B-02) 42
- Stony Brook (Segment MA84B-03) 44
- Stony Brook (Segment MA84B-04) 47
- Black Brook (Segment MA84A-17) 50
- Merrimack River (Segment MA84A-02) 52
- Beaver Brook (Segment MA84A-11) 57
- Merrimack River (Segment MA84A- 03) 60
- Richardson Brook (Segment MA84A-12) 64
- Trout Brook (Segment MA84A-13) 65
- Trull Brook (Segment MA84A-14) 66
- Merrimack River (Segment MA84A-04) 67
- Spicket River (Segment MA84A-10) 73
- Bare Meadow Brook (Segment MA84A-18) 77
- Merrimack River (Segment MA84A-05) 79
- Little River (Segment MA84A-09) 84
- Johnson Creek (Segment MA84A-15) 86
- Cobbler Brook (Segment MA84A-22) 88
- Powwow River (Segment MA84A-24) 90
- Powwow River (Segment MA84A-25) 92
- Back River (Segment MA84A-16) 93
- Powwow River (Segment MA84A-08) 95
- Merrimack River (Segment MA84A-06) 96
- Merrimack River (Segment MA84A-26) 101
- Plum Island River (Segment MA84A-27) 103

Merrimack River Basin - Lake Assessments 105
- Lake Attitash (Segment MA84002) 107
- Bailey Pond (Segment MA84003) 109
- Chadwicks Pond (Segment MA84006) 110
- Lake Cochichewick (Segment MA84008) 112
- Crystal Lake (Segment MA84010) 114
- Flint Pond (Segment MA84012) 116
- Forest Lake (Segment MA84014) 119
- Forge Pond (Segment MA84015) 121

Haggetts Pond (Segment MA84022) 123
Hoveys Pond (Segment MA84025) 125
Johnsons Pond (Segment MA84027) 127
Kenoza Lake (Segment MA84028) 129
Knops Pond/Lost Lake (Segment MA84084) 131
Long Pond (Segment MA84032) 134
Lake Mascuppic (Segment MA84037) 136
Massapoag Pond (Segment MA84087) 138
Mill Pond (Segment MA84038) 141
Mill Pond (Segment MA84081) 142
Mill Pond (Segment MA84039) 143
Millvale Reservoir (Segment MA84041) 144
Newfield Pond (Segment MA84046) 146
Lake Pentucket (Segment MA84051) 149
Lake Saltonstall (Segment MA84059) 151
Spectacle Pond (Segment MA84089) 152
Stevens Pond (Segment MA84064) 155
Uptons Pond (Segment MA84075) 156
Ward Pond (Segment MA84096) 157
Recommendations – Lakes 158
Literature Cited 160

LIST OF APPENDICES

APPENDIX A - DATA VALIDATION REPORT FOR 1999 DEP/DWM MERRIMACK WATERSHED MONITORING DATA

APPENDIX B - 1999 DEP DWM MERRIMACK RIVER BASIN SURVEY DATA

APPENDIX C - TECHNICAL MEMORANDUM (TM-84-4) MERRIMACK RIVER WATERSHED 1999 BIOLOGICAL ASSESSMENT

APPENDIX D - SUMMARY OF NPDES AND WMA PERMITTING INFORMATION, MERRIMACK RIVER BASIN

APPENDIX E - DMF SHELLFISH DATA, MERRIMACK RIVER BASIN

APPENDIX F- DEP 1999 GRANT AND LOAN PROGRAMS

APPENDIX G - DEP/WES MERRIMACK RIVER MICROBIAL INDICATOR STUDY 1999-2001

LIST OF TABLES AND FIGURES

Table 1. Estimates of trophic status for lakes in the Merrimack River Basin vii
Table 2. Summary of Massachusetts Surface Water Quality Standards 3
Table 3. 1998 303(d) List of Waters, Merrimack River Basin 15
Table 4. Merrimack River Basin lake trophic status estimates 106
Table 5. Non-native aquatic plant species locations in the Merrimack River Basin and their possible paths of downstream spreading 158

Figure 1. Merrimack River Basin Aquatic Life Use Assessment Summary – Rivers, Estuaries and Lakes xiii
Figure 2. Merrimack River Basin Fish Consumption Use Assessment Summary – Rivers, Estuaries and Lakes xv
Figure 3. Merrimack River Basin Primary and Secondary Contact Recreational Use Assessment Summary – Rivers and Estuaries xvii
Figure 4. Merrimack River Basin Aesthetics Use Assessment Summary – Rivers and Estuaries xix
Figure 5. Five-year cycle of the Watershed Approach 1
Figure 6. Merrimack River Basin Location (New England) 12
Figure 7. Lower Merrimack River Basin Drainage Area 12
Figure 8. Merrimack River Basin River and Estuary Segment Locations 28
Figure 9. Merrimack River Basin Lake Segment Locations identified by WBID 105

LIST OF ACRONYMS

7Q10	seven day, ten year low flow
ACEC	Area of Critical Environmental Concern
ACOE	Army Corps of Engineers
BDL	Below detection limit
BPJ	best professional judgment
BRP	Bureau of Resource Protection
CMR	Code of Massachusetts Regulations
CNOEC	chronic no observed effect concentration
CSO	Combined sewer overflow
CWA	Clean Water Act
DEM	Department of Environmental Management
DDT	Dichlordiphenyltrichloroethane
DMF	Division of Marine Fisheries
DMR	Discharge Monitoring Report
DO	dissolved oxygen
DWM	Division of Watershed Management
EPA	United States Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
LC_{50}	lethal concentration to 50% of the test organisms
MA DEP	Massachusetts Department of Environmental Protection
MassGIS	Massachusetts Geographic Information System
MDPH	Massachusetts Department of Public Health
MPN	most probable number
MRWC	Merrimack River Watershed Council
MVPC	Merrimack Valley Planning Commission
NAS/NAE	National Academy of Sciences/National Academy of Engineers
NAWQA	National Water-Quality Assessment
NECB	New England Coastal Basin
NPDES	National Pollutant Discharge Elimination System
ORS	Office of Research and Standards
ORW	Outstanding Resource Water
PALIS	Pond and Lake Information System
PCB	polychlorinated biphenols
PWS	public water supply
QA/QC	quality assurance/ quality control
RBP	rapid bioassessment protocol
SARIS	Stream and River Inventory System
SDWA	Safe Drinking Water Act
SWAP	Source Water Assessment Program
SWQS	Surface Water Quality Standards
TIE/TRE	toxicity identification evaluation /toxicity reduction evaluation
TMDL	total maximum daily load
TOC	total organic carbon
TOXTD	MA DEP DWM Toxicity Testing Database
TRC	total residual chlorine
USFWS	United States Fish & Wildlife Service
USGS	United States Geological Survey
WBID	Waterbody Identification Code
WBS	Waterbody System Database
WMA	Water Management Act
WWTP	waste water treatment plant

LIST OF UNITS

cfs	cubic feet per second	mg/L	milligram per liter
cfu	colony forming unit	mL/L	milliliter per liter
MGD	million gallons per day	NTU	nephelometric turbidity units
Mg/Kg	Milligram per kilogram	SU	standard units
µg/kg	microgram per kilogram		

EXECUTIVE SUMMARY
MERRIMACK RIVER BASIN 1999
WATER QUALITY ASSESSMENT REPORT

The Massachusetts Surface Water Quality Standards (SWQS) designate the most sensitive uses for which surface waters in the Commonwealth shall be protected. The Massachusetts Department of Environmental Protection (MA DEP) is responsible for the assessment of current water quality conditions, which is a key step in the successful implementation of the Massachusetts Watershed Approach. This critical phase provides an assessment of whether or not the designated uses are being met (support, partial support, non-support) or are not assessed, as well as basic information needed to focus resource protection and remediation activities later in the watershed management planning process.

This assessment report presents a summary of current water quality data/information in the Massachusetts portion of the Merrimack River Basin (exclusive of the Nashua, Concord and Shawsheen River basins) used to assess the status of the designated uses as defined in the SWQS. Each use, within a given segment, is individually assessed as 1) ***support***, 2) ***partial support***, or 3) ***non-support***. When too little current data/information exists or no reliable data are available the use is ***not assessed***. However, if there is some indication of water quality impairment, which is not "naturally occurring", the use is identified with an "Alert Status". It is important to note that not all waters are assessed. Many small and/or unnamed rivers and ponds are currently ***unassessed***; the status of their designated uses has never been reported to the United States Environmental Protection Agency (EPA) in the Commonwealth's 305(b) Report nor is information on these waters maintained in the Waterbody System (WBS) database.

There are a total of 19 freshwater rivers, streams, brooks or creeks (the term "rivers" will hereafter be used to include all) assessed in this report. These include: the mainstem Merrimack River, Martins Pond Brook (in the Salmon Brook subwatershed, which joins the mainstem in New Hampshire), Beaver and Stony brooks and an unnamed tributary locally known as "Reedy Meadow Brook" in the Stony Brook subwatershed, and the following direct tributaries to the mainstem river (upstream to downstream): Lawrence, Deep, Black, Beaver, Trull (and its Trout Brook tributary), and Richardson brooks, the Spicket River, Bare Meadow Brook, Little River, Johnson Creek, Cobbler Brook, and the Powwow River (including the Back River). Three estuarine areas, including the tidally-influenced mainstem Merrimack, Powwow, and Plum Island rivers, and 27 lakes, ponds or impoundments (the terms "lakes will hereafter be used to include all) in the Merrimack River Basin are also included in this report. These assessments represent approximately 24% of the 79 named streams and 46% (104.49) of the estimated 225.1 river miles in the basin. The remaining rivers are small and/or unnamed, and they are currently unassessed. Nearly all of the estuarine area is assessed, as are 28% of the 96 lakes, comprising 70% (3,375 out of 4,803) of the lake acreage. Ten of the lakes, representing 2,047 acres, are Class A public water supplies.

The status of the designated uses for these waterbodies is summarized in a segment format, which includes 25 river segments, five estuarine segments, and 27 lake segments. The designated uses, where applicable, include: *Aquatic Life, Fish Consumption, Drinking Water, Shellfishing, Primary* and *Secondary Contact Recreation* and *Aesthetics*.

AQUATIC LIFE USE – RIVERS, ESTUARIES, AND LAKES

The *Aquatic Life Use* is supported when suitable habitat (including water quality) is available for sustaining a native, naturally diverse, community of aquatic flora and fauna. Impairment of the *Aquatic Life Use* (non-support or partial support) may result from anthropogenic stressors that include point and/or nonpoint source(s) of pollution and hydrologic modification.

The status of the *Aquatic Life Use* in the Merrimack River Basin can be summarized as follows:

Rivers (miles)	Estuaries (square miles)	Lakes (acres)
5.9 miles SUPPORT **36.9 miles PARTIAL SUPPORT** **1.1 miles NON-SUPPORT** **60.59 miles NOT ASSESSED**	**6.97 square miles PARTIAL SUPPORT** **0.35 square miles NOT ASSESSED**	**534 acres PARTIAL SUPPORT** **2841 acres NOT ASSESSED**

As illustrated in Figure 1 (page xiii), of the 104.49 river miles in the Merrimack River Basin included in this report, a total of only 5.9 river miles (approximately 6%) are assessed as supporting the *Aquatic Life Use*. These include the upper portions of only two streams (Stony Brook and the Spicket River) and the entire length of an unnamed tributary (locally known as "Reedy Meadow Brook"). The *Aquatic Life Use* was assessed as impaired (partial or non-support) for 36% of the river miles while the majority (58%) of the river miles in the basin included in this report are currently not assessed for the *Aquatic Life Use*.

A total of 36.9 river miles (portions or all of five streams) are assessed as partial support for the *Aquatic Life Use* (Figure 1). The lower 8.5-miles of Stony Brook are impaired (partial support) as a result of moderate enrichment, but habitat quality degradation (sedimentation, low-flow conditions) is also suspected as a cause of impairment. One mile within this reach is also threatened by toxicity from an industrial discharge. The lower 3.8-mile reach of the Spicket River is also impaired (partial support) due to habitat alteration/modification and channelization, as well as urban runoff. Severe habitat degradation (sedimentation, trash and debris) adversely impacts Beaver Brook in Dracut. Although the cause of impairment (partial support 4.5 miles) in Cobbler Brook is unknown, organic enrichment, riparian disturbances, seasonal low-flow conditions, and flow alteration resulting from impoundment(s) are suspected. The *Aquatic Life Use* for the lower 15.9-mile reach of the freshwater portion of the mainstem Merrimack River (from Duck Island, Lowell to the confluence with Creek Brook in Haverhill), as well as the estuarine portion of the Merrimack River (6.97 square miles), is assessed as partial support because of elevated concentrations of total polychlorinated biphenyls (PCB) in whole fish samples (as opposed to edible fillets) collected from the Merrimack River downstream from Duck Island in Lowell. The PCB concentrations exceed the National Academy of Sciences/National Academy of Engineers (NAS/NAE) guideline for the protection of fish-eating wildlife. Source(s) of total PCB are unknown at this time and warrant further investigation.

Habitat/flow alteration impairs (non-support) the *Aquatic Life Use* for a total of 1.1 river miles in the Merrimack River Basin (Figure 1). There is a 0.7-mile reach of Merrimack River streambed (downstream from the Pawtucket Dam through Pawtucket Falls to the confluence with the Lowell Project tailrace) exposed as a result of hydromodification (flow is periodically diverted solely through the Northern canal system). Habitat quality is also impaired in the lower 0.4-mile reach of the Little River because of channel alteration (the river is culverted underground).

The majority of the lakes in the Merrimack River Basin (22 lakes representing 2,841 acres) are not assessed for the *Aquatic Life Use*. Five lakes, however, representing 16% of the lake acreage, are infested with non-native aquatic vegetation and are, therefore, assessed as impaired (partial support) for the *Aquatic Life Use* (Figure 1). The non-native aquatic vegetation includes the following: *Myriophyllum heterophyllum* (variable milfoil) found in Flint, Massapoag, and Spectacle ponds and Knops Pond/Lost Lake; *Cabomba caroliniana* (fanwort) found in Knops Pond/Lost Lake, Newfield and Spectacle ponds; *Potamogeton crispus* (curly-leaf pondweed) found in Newfield, Massapoag, and Spectacle ponds; *Najas minor* (European naiad) found in Flint Pond and *Myriophyllum spicatum* (Eurasian milfoil) found in Newfield Pond. These five non-native aquatic plant species are particularly invasive and reproduce vegetatively; therefore, they may spread readily downstream on currents or between lakes by mechanical transport.

Oxygen depletion in the hypolimnion (summer surveys) was another cause of partial support that was documented in Massapoag, Newfield and Spectacle ponds. This oxygen depletion is presumably the result of organic enrichment.

While not an indicator used to assess the status of the *Aquatic Life Use*, estimates of trophic status of the lakes in the Merrimack River Basin are summarized in Table 1.

Table 1. Estimates of trophic status for lakes in the Merrimack River Basin.

TROPHIC STATUS	NUMBER OF PONDS	ACRES
Eutrophic	6	703
Hypereutrophic	3	95
Undetermined*	18	2,577
Total	27	3,375

* It should be noted that some lakes or portions of lakes are listed as undetermined when indicators were not readily observable. With this approach, only the most obvious impairments are reported and, therefore, the assessment of lakes in the Merrimack River Basin is limited to a "best case" picture. Potentially more of the lake acreage would be listed as impaired, or in a more enriched trophic status, if more variables were measured and more criteria assessed.

FISH CONSUMPTION USE – RIVERS, ESTUARIES AND LAKES

The *Fish Consumption Use* is supported when there are no pollutants present that result in unacceptable concentrations in edible portions (as opposesd to whole fish - see *Aquatic Life Use*) of marketable fish or for the recreational use of fish, other aquatic life or wildlife for human consumption. The assessment of the *Fish Consumption Use* is made using the most recent list of Fish Consumption Advisories issued by the Massachusetts Executive Office of Health and Human Services, Department of Public Health (MDPH), Bureau of Environmental Health Assessment (MDPH 2001a). The MDPH list identifies waterbodies where elevated levels of a specified contaminant in edible portions of freshwater species poses a health risk for human consumption; hence the *Fish Consumption Use* is assessed as non-support in these waters. In July 2001, MDPH issued new (updated from 1994) consumer advisories on fish consumption and mercury contamination (MDPH 2001b). Because of the statewide advisories, no waters can be assessed as either support or partial support for the *Fish Consumption Use.* The statewide advisories read as follows:

> The MDPH "is advising pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age to refrain from eating the following marine fish; shark, swordfish, king mackerel, tuna steak and tilefish. In addition, MDPH is expanding its previously issued statewide fish consumption advisory which cautioned pregnant women to avoid eating fish from all freshwater bodies due to concerns about mercury contamination, to now include women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age (MDPH 2001b)."
>
> Additionally, MDPH "is recommending that pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age limit their consumption of fish not covered by existing advisories to no more than 12 ounces (or about 2 meals) of cooked or uncooked fish per week. This recommendation includes canned tuna, the consumption of which should be limited to 2 cans per week. Very small children, including toddlers, should eat less. Consumers may wish to choose to eat light tuna rather than white or chunk white tuna, the latter of which may have higher levels of mercury (MDPH 2001b)." MDPH's statewide advisory does not include fish stocked by the state Division of Fisheries and Wildlife or farm-raised fish sold commercially.

Recent investigations by the United States Geological Survey (USGS) including their National Mercury Pilot Study, New England Coastal Basin (NECB) Mercury Study, Toxics Substances Hydrology Program, and Urban Land Use Gradient Study showed some of the highest mercury concentrations in the country were in the NECB study area. The dominant source of mercury identified in the NECB study area was atmospheric deposition. A directed study of fish in lakes in northeastern Massachusetts, the MA DEP Merrimack Valley Fish Study, was also recently performed by the MA DEP Office of Research and Standards (ORS) to examine possible spatial patterns in the occurrence of higher fish mercury concentrations and to compare the fish contamination situation in this localized geographical region to state wide and regional data. This region was recently identified through the use of an air deposition model as having the highest predicted annual levels of recent wet and dry atmospheric deposition of mercury in the state. The area has the state's largest concentration of point sources of atmospheric mercury emissions: three municipal solid waste incinerators and a medical waste incinerator. While historic records of atmospheric mercury deposition in this area do not exist, past widespread burning of coal for domestic heat and industrial boilers in the late nineteenth and first half of the twentieth centuries probably contributed to a relatively high background mercury signature in the environment of this part of the state.

Because of elevated levels of mercury in edible portions of fish, the status of the *Fish Consumption Use* in the Merrimack River Basin is as follows:

***Fish Consumption Use* Summary**

Rivers (miles)	Estuaries (square miles)	Lakes (acres)
20.8 miles NON-SUPPORT **83.69 miles NOT ASSESSED**	**7.32 square miles NOT ASSESSED**	**2,583 acres NON-SUPPORT** **792 acres NOT ASSESSED**

MDPH has issued an advisory for the mainstem Merrimack River for all towns between Tyngsborough and Methuen (MDPH 2001a). The *Fish Consumption Use* is, therefore, assessed as non-support for a total of 20.8 miles from the MA/NH state line to the Essex Dam in Lawrence (Figure 2, page xv). Because of the statewide advisory, the use is not assessed for the remaining 83.69 riverine miles or the 7.32 square mile estuarine area. MDPH has also issued fish consumption advisories for 17 lakes in the Merrimack River Basin because of health concerns related to mercury. These waterbodies include: Attitash, Cochichewick, Pentucket, Saltonstall, Crystal, Kenoza and Forest lakes; Chadwick, Haggets, Hoveys, Johnsons, Flint, Long, Newfield, Masspoag and Stevens ponds; and Millvale Reservoir (MDPH 2001a). The *Fish Consumption Use* is, therefore, assessed as non-support for these lakes, a total of 2,583 acres. Ten of these lakes, totaling 2,047 acres, are Class A public water supplies. The remaining 792 lake acres (10 lakes) in the Merrimack River Basin are not assessed for this use.

DRINKING WATER USE – RIVERS AND LAKES

The term *Drinking Water Use* has been used to indicate sources of public drinking water. While this use is not assessed in this report, information on drinking water source protection and finish water quality is available at http://www.state.ma.us/dep/brp/dws/dwshome.htm and from the Merrimack River Basin public water suppliers. These waters are subject to stringent regulation in accordance with the Massachusetts Drinking Water Regulations. MA DEP's Drinking Water Program (DWP) has primacy for implementing the provisions of the federal Safe Drinking Water Act. DWP has also initiated work on its Source Water Assessment Program (SWAP), which requires that the Commonwealth delineate protection areas for all public ground and surface water sources, inventory land uses in these areas that may present potential threats to drinking water quality, determine the susceptibility of water supplies to contamination from these sources, and publicize the results. Except for suppliers with surface water sources for which a waiver from filtration has been granted (these systems also monitor surface water quality), public water suppliers monitor their finished water (tap water) for major categories of contaminants (e.g., bacteria, volatile and synthetic organic compounds, inorganic compounds, etc.) and report their data to DWP.

SHELLFISHING USE – ESTUARIES

The *Shellfishing Use* is supported when shellfish harvested from approved Open Shellfish Areas (Class SA) are suitable for consumption without depuration and shellfish harvested from approved Restricted Shellfish Areas (Class SB) are suitable for consumption with depuration. The Division of Marine Fisheries (DMF) classifies the shellfishing areas in the Merrimack River Basin. The *Shellfishing Use* for this report was assessed using the DMF shellfishing closure list dated October 2000 (DFWELE 2000). The status of the 2,948.402 acres of shellfishing beds in the Merrimack River Basin (including areas that extend into open-water and areas not specifically included in this assessment report) is as follows:

DMF Classification Type	MA DEP Use Support Status	DMF Area (acres)	% of total DMF acreage
Approved	Support	179.403	6%
Conditionally Approved	Partial support	0	0%
Prohibited	Non-support	2,768.999	94%

PRIMARY AND *SECONDARY CONTACT RECREATION USE* – RIVERS, ESTUARIES, AND LAKES

The *Primary Contact Recreational Use* is supported when conditions are suitable (fecal coliform bacteria densities, pH, temperature, turbidity and aesthetics meet the Surface Water Quality Standards) for any

recreational or other water related activity during which there is prolonged and intimate contact with the water with a significant risk of ingestion. Activities include, but are not limited to, wading, swimming, diving, surfing and water skiing. The *Secondary Contact Recreational Use* is supported when conditions are suitable for any recreational or other water use during which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities. For lakes, macrophyte cover and/or transparency (Secchi disk depth) data are assessed to evaluate the status of the recreational uses.

The status of the *Primary Contact Recreational* uses in the Merrimack River Basin is as follows:

Rivers (miles)	Estuaries (square miles)	Lakes (acres)
8.9 miles NON-SUPPORT **95.59 miles NOT ASSESSED**	**4.67 square miles SUPPORT** **2.65 square miles NOT ASSESSED**	**167 acres NON-SUPPORT** **3208 acres NOT ASSESSED**

The status of the *Secondary Contact Recreational* uses in the Merrimack River Basin is as follows:

Rivers (miles)	Estuaries (square miles)	Lakes (acres)
4.7 miles NON-SUPPORT **99.79 miles NOT ASSESSED**	**4.67 square miles SUPPORT** **2.65 square miles NOT ASSESSED**	**163 acres SUPPORT** **167 acres NON-SUPPORT** **3045 acres NOT ASSESSED**

As illustrated in Figure 3 (page xvii), the majority (91%) of the river miles in the Merrimack River Basin are not assessed for the *Primary Contact Recreational Use.* Because of the periodic public beach closures at the Lowell Heritage State Park, 4.2 miles of the mainstem Merrimack River are impaired (non-support) for the *Primary Contact Recreational Use.* This portion of the Merrimack River, however, is not assessed for the *Secondary Contact Recreational Use.* As a result of degraded aesthetic quality conditions and/or combined sewer overflow (CSO) discharges, portions of three tributaries to the Merrimack River are impaired (non-support) for both the *Primary* and *Secondary Contact Recreational* uses. These include a half-mile reach of Beaver Brook affected by objectionable deposits, turbidity, and oil from CSO discharges and illegal dumping, a 3.8-mile reach of the Spicket River because of urban runoff, and a 0.4-mile reach of the Little River as result of elevated bacteria levels from CSO discharges. Fecal coliform bacteria data collected by the DMF Shellfish Sanitation Program were used to determine that a total of 64% of the estuarine area (east of the Route 95 bridge) in the Merrimack River Basin supports the *Primary* and *Secondary Contact Recreational* uses. The estuarine areas west of the Route 95 bridge (including a portion of the mainstem Merrimack River and the Powwow River are currently not assessed for the recreational uses (DMF does not sample upstream of the bridge).

Few lakes in the Merrimack River Basin have recently been surveyed for variables used to assess the status of the recreational uses (i.e., bacteria data, macrophyte cover, transparency). As a result, the majority (over 90%) of the lake acreage is not assessed for the *Primary* and *Secondary Contact Recreational uses.* The recreational uses are, however, assessed as impaired (non-support) in 167 acres (portions of Flint, Massapoag, Newfield and Spectacle ponds) because of very dense macrophyte cover. The *Secondary Contact Recreational Use* is assessed as support for a total of 163 acres (the "open-water" acreage) in these four waterbodies.

AESTHETICS USE – RIVERS, ESTUARIES, AND LAKES

The *Aesthetics Use* is supported when surface waters are free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

The status of the *Aesthetics Use* in the Merrimack River Basin is as follows:

Rivers (miles)	Estuaries (square miles)	Lakes (acres)
30.5 miles SUPPORT **9.2 miles NON-SUPPORT** **64.79 miles NOT ASSESSED**	**7.27 square miles SUPPORT** **0.05 square miles NOT ASSESSED**	**163 acres SUPPORT** **167 acres NON SUPPORT** **3095 acres NOT ASSESSED**

As illustrated in Figure 4 (page xix), many of the tributaries to the Merrimack River are not assessed for the *Aesthetics Use*. The *Aesthetics Use* is impaired (non-support) in portions or all of four tributaries (Beaver Brook, Spicket and Little rivers, and Cobbler Brook) as a result of objectionable deposits, odor, oils and/or turbidity resulting from urban runoff, illegal dumping and combined sewer overflows. The entire mainstem and estuarine portion of the Merrimack River, however, is aesthetically acceptable and, therefore, assessed as support for the *Aesthetics Use*. The estuarine area of the Powwow River (0.05 square miles) was not assessed for the *Aesthetics Use*.

The majority of the lake acreage (92%) in the Merrimack River Basin is currently not assessed for the *Aesthetics Use*. The "open-water" acreage (a total of 163 acres) of Flint, Massapoag, Newfield and Spectacle ponds, is assessed as support for the *Aesthetics Use*, however, the dense/very dense macrophyte cover along the shorelines of Massapoag, Newfield and Spectacle ponds (a total of 167 acres) impairs (non-support) the *Aesthetic Use*.

RECOMMENDATIONS – RIVERS, ESTUARIES AND LAKES

In addition to specific issues for the individual segments, the evaluation of current water quality conditions in the Merrimack River Basin has revealed the need for the following:

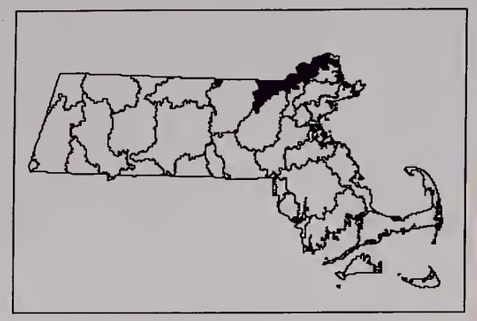
- Conduct additional monitoring (e.g., passive water column PCB samplers, whole fish tissue), to determine the extent, and if necessary, source(s) of PCB contamination along the mainstem Merrimack River. Determine locations of current and historical sources of PCB in the River and in its tributaries.
- Conduct biological and water quality monitoring to evaluate the effects of National Pollutant Discharge Elimination System (NPDES) permittees, power plants, CSOs and nonpoint sources of pollution and to document any changes in water quality conditions as a result of infrastructure improvements/pollution abatement controls.
- Evaluate the CSO Control Plans for Lowell Regional Water and Wastewater Utilities, Greater Lawrence Sanitary District, and the Haverhill Water Pollution Control Facility, and, when approved, require that they implement CSO controls expeditiously to address these known sources of pollution.
- Develop and reissue NPDES permits for surface water discharges in the Merrimack River Basin. If dischargers in the Basin have problems meeting their whole effluent toxicity limits, the need for a toxicity identification evaluation/toxicity reduction evaluation (TIE/TRE) may be warranted.
- As part of the Water Management Act (WMA) 5-year review process, MA DEP should continue to evaluate compliance with registration and/or permit limits for suppliers in the Merrimack River Basin. Work with water suppliers to optimize water withdrawal and reservoir management practices to maintain minimum streamflow.
- Habitat quality evaluations should be conducted along streams/rivers to assess streamflow conditions as related to water withdrawals and/or flow management practices (e.g., outlet control operations). Collect additional data, where necessary, to determine the frequency, duration, and spatial extent of the low flow conditions.
- Habitat quality evaluations should be conducted along streams/rivers to document areas of erosion and sedimentation. Develop and implement best management practices (BMPs) to control storm water runoff.
- Work with the Division of Marine Fisheries, Coastal Zone Management and local communities to identify and reduce sources of contamination (e.g., storm water, failing septic systems, etc.) to shellfish areas.
- Work with the Merrimack River Watershed Council to identify causes and sources of contamination, conduct stream cleanups, and encourage/strengthen local stewardship and with the Stream Teams to implement their priority actions.
- When the MA DEP Drinking Water Program SWAP evaluations are completed, develop and implement recommendations to protect the Class A rivers and lakes in the Merrimack River Basin.
- Coordinate with the MA Department of Environmental Management (MA DEM) and/or other groups conducting lake and watershed surveys to generate quality assured lakes data. As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

- Review data from "Beaches Bill" required water quality testing (bacteria sampling at all formal bathing beaches) to assess the status of the recreational uses.
- Review recommendations for long-term restoration/preservation from lake diagnostic/feasibility studies and watershed management plans and effect their implementation. Implement recommendations from the nutrient total maximum daily load (TMDL) analysis currently being prepared by MA DEP.
- Monitor and control the spread and growth of exotic aquatic and wetland vegetation. Determine the effectiveness of the herbicide treatment on the non-native, aquatic plant infestations. Prevent the further spread of these plants to unaffected areas (of this pond and to other ponds) by alerting pond-users to the problem and responsibility of spreading these exotic species. This should include posting of boat access points with educational warning signs.

Intentionally left blank

MERRIMACK RIVER BASIN

Aquatic Life Use Assessment Summary – Rivers, Estuaries and Lakes



Spicket River (MA84A-10)
SUPPORT: 2.6 miles
PARTIAL SUPPORT: 3.8 miles
Causes: Habitat alteration, unknown
(suspected: organic enrichment)
Sources: Municipal point sources, urban runoff/storm sewers, habitat modification (removal of riparian zone)
(suspected: industrial point sources)

Little River (MA84A-09)
NON-SUPPORT: 0.4 miles
NOT ASSESSED: 3.9 miles
Causes: Habitat alteration
Sources: Channelization, habitat modification

Cobbler Brook (MA84A-22)
PARTIAL SUPPORT
Causes: Unknown
(suspected: organic enrichment, habitat and flow alteration)
Sources: Unknown
(suspected: urban runoff, hydromodification)

Newfield Pond (MA84046)
PARTIAL SUPPORT
Causes: Exotic species, organic enrichment/low DO
Sources: Unknown

Beaver Brook (MA84A-11)
PARTIAL SUPPORT
Causes: Habitat degradation
(suspected: organic enrichment, nutrients)
Sources: Habitat modification
(suspected: upstream impoundments)

Flint Pond (MA84012)
PARTIAL SUPPORT
Causes: Exotic species
Sources: Unknown

Massapoag Pond (MA84087)
PARTIAL SUPPORT
Causes: Exotic species, organic enrichment/low DO
Sources: Unknown

Knops Pond/Lost Lake (MA84084)
PARTIAL SUPPORT
Causes: Exotic species
Sources: Unknown

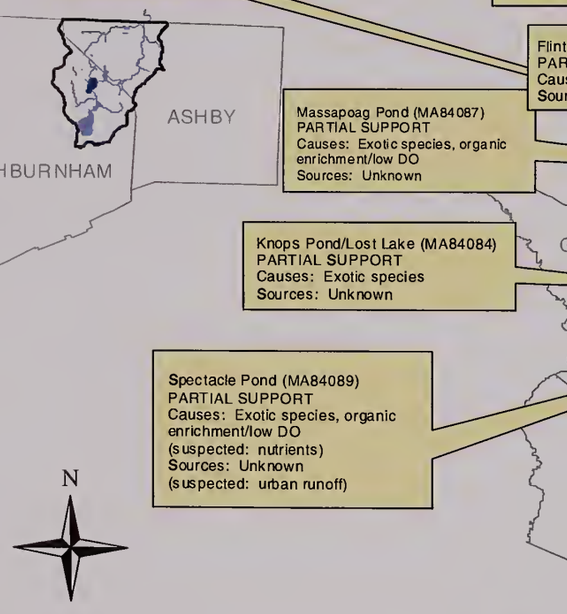
Spectacle Pond (MA84089)
PARTIAL SUPPORT
Causes: Exotic species, organic enrichment/low DO
(suspected: nutrients)
Sources: Unknown
(suspected: urban runoff)

Stony Brook (MA84B-04)
PARTIAL SUPPORT
Causes: Organic enrichment, unknown
(suspected: habitat and flow alteration)
Sources: Unknown

Merrimack River (MA84A-02)
NON-SUPPORT: 0.7 miles
NOT ASSESSED: 2.1 miles
Causes: Flow alteration
Sources: Hydromodification

Merrimack River
(MA84A-03, MA 84A-04, MA84A-05, MA84A-06)
PARTIAL SUPPORT
Causes: PCBs
Sources: Unknown

Stony Brook (MA84B-03)
SUPPORT: 1.8 miles
PARTIAL SUPPORT: 5.2 miles
Causes: Effluent toxicity, organic enrichment, unknown (suspected: habitat and flow alteration)
Sources: Industrial point source, unknown



LEGEND

- Support
- Impaired (partial support and non-support)
- Not Assessed Waters
- Unassessed Waters
- Segment Break
- Town Outlines
- Basin Outline

Figure 1. Merrimack River Basin *Aquatic Life Use* Assessment Summary – Rivers, Estuaries, and Lakes.

MERRIMACK RIVER BASIN

Fish Consumption Use Assessment Summary - Rivers, Estuaries, and Lakes

NOTE: MDPH Statewide Advisory

In July 2001, MDPH issued new consumer advisories for fish consumption because of mercury contamination. The MDPH "...is advising pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age to refrain from eating the following marine fish; shark, swordfish, king mackerel, tuna steak and tilefish. In addition, MDPH is expanding its previously issued statewide fish consumption advisory which cautioned pregnant women to avoid eating fish from all freshwater bodies due to concerns about mercury contamination, to now include women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age (MDPH 2001b)."

Additionally, MDPH "...is recommending that pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age limit their consumption of fish not covered by existing advisories to no more than 12 ounces (or about 2 meals) of cooked or uncooked fish per week. This recommendation includes canned tuna, the consumption of which should be limited to 2 cans per week. Very small children, including toddlers, should eat less (MDPH 2001b)."

Because of the statewide advisory no waters can be assessed as support or partial support for the *Fish Consumption Use.*

MDPH issued site-specific advisories for 17 lakes in the Merrimack River Basin due to elevated levels of mercury in edible fillets of fish.

Chadwicks Pond	MA84006
Crystal Lake	MA84010
Flint Pond	MA84012
Forest Lake	MA84014
Haggets Pond	MA84022
Hoveys Pond	MA84025
Johnsons Pond	MA84027
Kenoza Lake	MA84028
Lake Attitash	MA84002
Lake Cochichewick	MA84008
Lake Pentucket	MA84051
Lake Saltonstall	MA84059
Long Pond	MA84032
Massapoag Pond	MA84087
Millvale Reservoir	MA84041

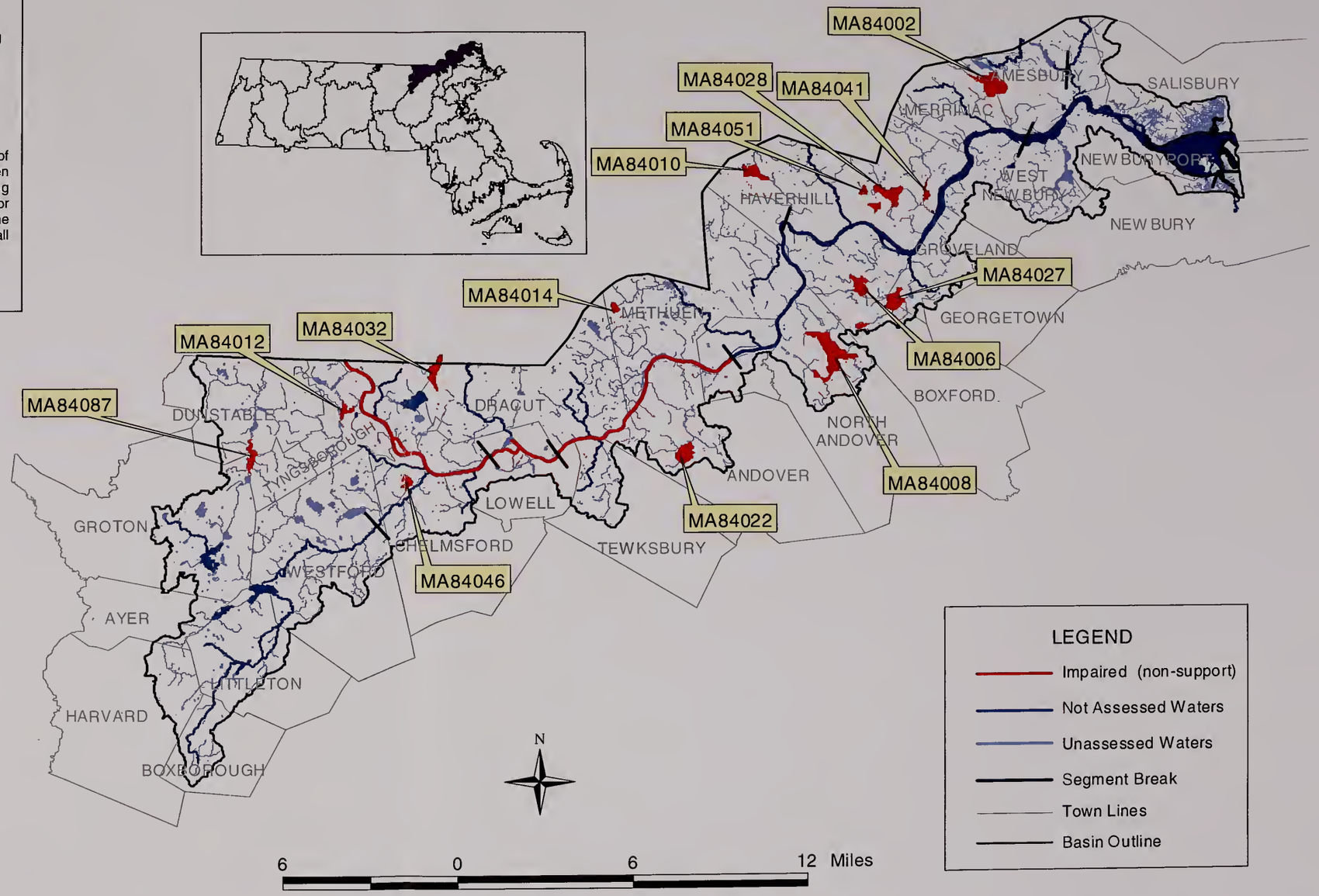
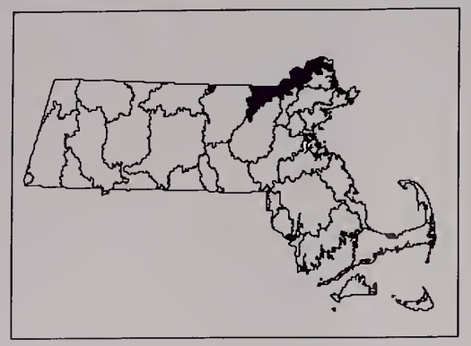


Figure 2. Merrimack River Basin *Fish Consumption Use* Assessment Summary Rivers, Estuaries and Lakes.

MERRIMACK RIVER BASIN

Primary and *Secondary Contact Recreational Uses* Assessment Summary

Rivers and Estuaries



Little River (MA84A-09)
NON-SUPPORT: 0.4 miles
NOT ASSESSED: 3.9 miles
Causes: Pathogens
Sources: CSO

Spicket River (MA84A-10)
NON-SUPPORT: 3.8 miles
NOT ASSESSED: 2.6 miles
Causes: Objectional deposits
Sources: Urban runoff

Beaver Brook (MA84A-11)
NON-SUPPORT: 0.5 miles
NOT ASSESSED: 3.7 miles
Causes: Objectionable deposits, turbidity, oil
Sources: Dumping, CSO

Merrimack River (MA84A-01)
NON-SUPPORT: 1.4 miles Primary Contact Recreation
NOT ASSESSED: 7.8 miles Primary Contact Recreation
NOT ASSESSED: 9.2 miles Secondary Contact Recreation
Causes: Pathogens
Sources: CSO, urban runoff/storm sewers
(suspected: dense waterfowl populations)

Merrimack River (MA84A-02)
NON-SUPPORT Primary Contact
NOT ASSESSED Secondary Contact
Causes: Pathogens
Sources: CSO
(suspected: urban runoff)

AMESBURY
SALISBURY
MERRIMAC
NEWBURYPORT
WEST NEWBURY
HAVERHILL
NEWBURY
GROVELAND
METHUEN
GEORGETOWN
BOXFORD
NORTH ANDOVER
DRACUT
DUNSTABLE
TYNGSBOROUGH
ANDOVER
WESTFORD
TEWKSBURY
CHELMSFORD
ASHBY
ASHBURNHAM
AYER
LITTLETON
HARVARD
BOXBOROUGH

N

6 0 6 12 Miles

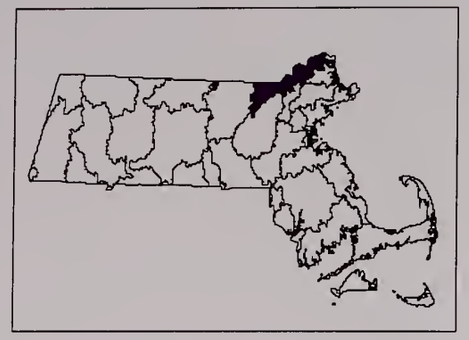
LEGEND

- Support
- Impaired (partial support and non-support)
- Not Assessed Waters
- Unassessed Waters
- Segment Break
- Town Outlines
- Basin Outline

Figure 3. Merrimack River Basin *Primary* and *Secondary Recreational Use* Assessment Summary – Rivers, Estuaries, and Lakes.

MERRIMACK RIVER BASIN

Aesthetics Use Assessment Summary – Rivers and Estuaries



Cobbler Brook (MA84A-22)
NON-SUPPORT
Causes: Objectionable deposits
Sources: Dumping

Spicket River (MA84A-10)
SUPPORT: 2.6 miles
NON-SUPPORT: 3.8 miles
Causes: Objectionable deposits
Sources: Urban runoff

Beaver Brook (MA84A-11)
NON-SUPPORT: 0.5 miles
NOT ASSESSED: 3.7 miles
Causes: Objectionable deposits, turbidity, oil
Sources: Dumping, CSO

Little River (MA84A-09)
NOT ASSESSED: 3.9 miles
NON-SUPPORT: 0.4 miles
Causes (suspected): Objectionable odor and turbidity
Sources: CSO

AMESBURY
SALISBURY
MERRIMAC
NEWBURYPORT
WEST NEWBURY
HAVERHILL
NEWBURY
GROVELAND
METHUEN
GEORGETOWN
BOXFORD
NORTH ANDOVER
ANDOVER
DUNSTABLE
TYNGSBOROUGH
TEWKSBURY
LOWELL
GROTON
WESTFORD
CHELMSFORD
AYER
LITTLETON
HARVARD
BOXBOROUGH
ASHBY
ASHBURNHAM

N

6 0 6 12 Miles

LEGEND

- Support
- Impaired (partial support and non-support)
- Not Assessed
- Unassessed Waters
- Segment Break
- Town Outlines
- Basin Outline

Figure 4. Merrimack River Basin *Aesthetics Use* Assessmary Summary – Rivers and Estuaries.

INTRODUCTION

The Massachusetts Watershed Initiative is a collaborative effort between state and federal environmental agencies, municipal agencies, citizens, non-profit groups, businesses and industries in the watershed. The mission is to improve water quality conditions and to provide a framework under which the restoration and/or protection of the watershed's natural resources can be achieved. Implementation of this project is underway in a process known as the "Watershed Approach". The five-year cycle of the Watershed Approach, as illustrated in Figure 5, provides the management structure to carry out the mission. This report presents the current assessment of water quality conditions in the Merrimack River Basin. The assessment is based on information that has been researched and developed by the Massachusetts Department of Environmental Protection (MA DEP) through the first three years (information gathering, monitoring, and assessment) of the five-year cycle in partial fulfillment of MA DEP's federal mandate to report on the status of the Commonwealth's waters under the Federal Water Pollution Control Act (commonly known as the Clean Water Act [CWA]).

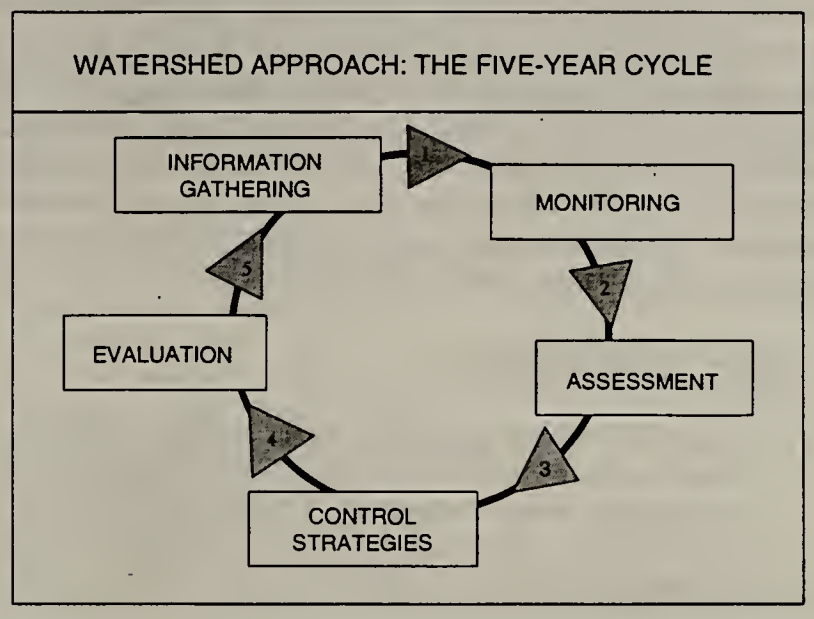


Figure 5: Five-year cycle of the Watershed Approach.

The goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (Environmental Law Reporter 1988). To meet this objective, the CWA requires states to develop information on the quality of the Nation's water resources and report this information to the United States Environmental Protection Agency (EPA), the United State Congress, and the public. Together, these agencies are responsible for implementation of the CWA mandates. Under Section 305(b) of the Federal Clean Water Act, MA DEP must submit a statewide report every two years to the EPA, which describes the status of water quality in the Commonwealth. The most recent 305(b) Report is the *Commonwealth of Massachusetts Summary of Water Quality 2000* (MA DEP 2000a). The 305(b) statewide report is based on the compilation of information for the Commonwealth's 27 watersheds. The 305(b) Report compiles data from a variety of sources and provides an evaluation of water quality, progress made towards maintaining and restoring water quality, and the extent to which problems remain at the statewide level. At the watershed level, instream biological, habitat, physical/chemical, toxicity data and other information are evaluated to assess the status of water quality conditions. This analysis follows a standardized process described below (Assessment Methodology).

ASSESSMENT METHODOLOGY

WATER QUALITY CLASSIFICATION

The Massachusetts Surface Water Quality Standards (SWQS) designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected; prescribe minimum water quality criteria required to sustain the designated uses; and include provisions for the prohibition of discharges (MA DEP 1996). These regulations should undergo public review every three years. The surface waters are segmented and each segment is assigned to one of the six classes described below. Each class is identified by the most sensitive and, therefore, governing water uses to be achieved and protected. Surface waters may be suitable for other beneficial uses, but shall be regulated by the MA DEP to protect and enhance the designated uses.

Inland Water Classes

1. ***Class A*** *– These waters are designated as a source of public water supply. To the extent compatible with this use they shall be an excellent habitat for fish, other aquatic life and wildlife, and suitable for primary and secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters (ORWs) under 314 Code of Massachusetts Regulations (CMR) 4.04(3).*

2. ***Class B*** *– These waters are designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation. Where designated they shall be suitable as a source of water supply with appropriate treatment. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.*

3. ***Class C*** *– These waters are designated as a habitat for fish, other aquatic life and wildlife, and for secondary contact recreation. These waters shall be suitable for the irrigation of crops used for consumption after cooking and for compatible industrial cooling and process uses. These waters shall have good aesthetic value.*

Coastal and Marine Classes

4. ***Class SA*** *– These waters are designated as an excellent habitat for fish, other aquatic life and wildlife and for primary and secondary recreation. In approved areas they shall be suitable for shellfish harvesting without depuration (Open Shellfishing Areas). These waters shall have excellent aesthetic value.*

5. ***Class SB*** *– These waters are designated as a habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. In approved areas they shall be suitable for shellfish harvesting with depuration (Restricted Shellfishing Areas). These waters shall have consistently good aesthetic value.*

6. ***Class SC*** *– These waters are designated as a habitat for fish, other aquatic life, and wildlife and for secondary contact recreation. They shall also be suitable for certain industrial cooling and process uses. These waters shall have good aesthetic value.*

The CWA Section 305(b) water quality reporting process is an essential aspect of the Nation's water pollution control effort. It is the principal means by which EPA, Congress, and the public evaluate existing water quality, assess progress made in maintaining and restoring water quality, and determine the extent of remaining problems. In so doing, the states report on waterbodies within the context of meeting their designated uses (described above in each class). The designated uses include: *Aquatic Life, Fish Consumption, Drinking Water, Primary* and *Secondary Contact Recreation, Shellfishing* and *Aesthetics.* Three subclasses of Aquatic Life are also designated in the standards: Cold Water Fishery (capable of sustaining a year-round population of cold water aquatic life, such as trout), Warm Water Fishery (waters that are not capable of sustaining a year-round population of cold water aquatic life), and Marine Fishery (suitable for sustaining marine flora and fauna).

The SWQS, summarized in Table 2, prescribes minimum water quality criteria to sustain the designated uses. Furthermore, these standards describe the hydrological conditions at which water quality criteria must be met (MA DEP 1996). In rivers, the lowest flow conditions at and above which criteria must be met are the lowest mean flow for seven consecutive days to be expected once in ten years (7Q10). In

Table 2. Summary of Massachusetts Surface Water Quality Standards (MA DEP 1996). *Note*: *Italics are direct quotations.*

Dissolved Oxygen	Class A, BCWF*, SA : ≥ 6.0 mg/L and ≥ 75% saturation unless background conditions are lower Class BWWF**, SB: ≥ 5.0 mg/L and ≥ 60% saturation unless background conditions are lower Class C: Not ≤ 5.0 mg/L for more than 16 of any 24 –hour period and not ≤ 3.0 mg/L anytime unless background conditions are lower; levels cannot be lowered below 50% saturation due to a discharge Class SC: Not ≤ 5.0 mg/L for more than 16 of any 24 –hour period and not ≤ 4.0 mg/L anytime unless background conditions are lower; and 50% saturation; levels cannot be lowered below 50% saturation due to a discharge
Temperature (maximum mean monthly)	Class A: ≤ 68°F (20°C) and Δ 1.5°F (0.8°C) for Cold Water and ≤ 83°F (28.3°C) and Δ 1.5°F (0.8°C) for Warm Water. Class BCWF: ≤ 68°F (20°C) and Δ3°F (1.7°C) due to a discharge Class BWWF: ≤ 83°F (28.3°C) and Δ3°F (1.7°C) in lakes, Δ5°F (2.8°C) in rivers Class C, SC: ≤85°F (29.4°C) nor Δ5°F (2.8°C) due to a discharge Class SA: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and Δ1.5°F (0.8°C) Class SB: ≤85°F (29.4°C) nor a maximum daily mean of 80°F (26.7°C) and Δ1.5°F (0.8°C) between July through September and Δ 4.0°F (2.2°C) between October through June
pH	Class A, BCWF, BWWF: 6.5 – 8.3 SU and Δ0.5 outside the background range. Class C: 6.5 – 9.0 SU and Δ1.0 outside the naturally occurring range. Class SA, SB: 6.5 – 8.5 SU and Δ0.2 outside the normally occurring range. Class SC: 6.5 – 9.0 SU and Δ0.5 outside the naturally occurring range.
Fecal Coliform Bacteria Class A criteria applied to the *Drinking Water Use* Class B criteria applied to *Primary* and *Secondary Contact Recreational* uses	Class A: an arithmetic mean of < 20 organisms /100mL in any representative set of samples and < 10% of the samples > 100 organisms/100mL. Class B: a geometric mean of < 200 organisms /100mL in any representative set of samples and < 10% of the samples > 400 organisms /100mL. (This criterion can be applied on a seasonal basis at the discretion of the MA DEP.) Class C: a geometric mean of < 1000 organisms /100ml, and < 10% of the samples > 2000 organisms/100 mL. Class SA: approved Open Shellfish Areas: a geometric mean (MPN method) of < 14 organisms/100 mL and < 10% of the samples > 43 organisms/100mL (MPN method). Waters not designated for shellfishing: < a geometric mean of 200 organisms in any representative set of samples, and < 10% of the samples > 400 organisms /100mL. (This criterion can be applied on a seasonal basis at the discretion of the MA DEP.) Class SB: approved Restricted Shellfish Areas: < a fecal coliform median or geometric mean (MPN method) of 88 organisms/100mL and < 10% of the samples > 260 organisms /100mL (MPN method). Waters not designated for shellfishing: < a geometric mean of 200 organisms in any representative set of samples, and < 10% of the samples > 400 organisms /100mL. (This criterion can be applied on a seasonal basis at the discretion of the MA DEP.) Class SC: < a geometric mean of 1000 organisms/100mL and < 10% of the samples > 2000 organisms/100ml.
Solids	All Classes: *These waters shall be free from floating, suspended, and settleable solids in concentrations or combinations that would impair any use assigned to each class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.*
Color and Turbidity	All Classes: *These waters shall be free from color and turbidity in concentrations or combinations that are aesthetically objectionable or would impair any use.*
Oil & Grease	Class A, SA: *Waters shall be free from oil and grease, petrochemicals and other volatile or synthetic organic pollutants.* Class SA: *Waters shall be free from oil and grease and petrochemicals.* Class B, C, SB, SC: *Waters shall be free from oil* and *grease, petrochemicals that produce a visible film on the surface of the water, impart an oily taste to the water or an oily or other undesirable taste to the edible portions of aquatic life, coat the banks or bottom of the water course or are deleterious or become toxic to aquatic life.*
Taste and Odor	Class A, SA: *None other than of natural origin.* Class B, C, SB, SC: *None in such concentrations or combinations that are aesthetically objectionable, that would impair any use assigned to each class, or that would cause tainting or undesirable flavors in the edible portions of aquatic life.*
Aesthetics	All Classes: *All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.*
Toxic Pollutants	All Classes: *All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife… The division shall use the recommended limit published by EPA pursuant to 33 USC 1251, 304(a) as the allowable receiving water concentrations for the affected waters unless a site-specific limit is established.*
Nutrients	*Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication.*

*Class BCWF = Class B Cold Water Fishery, ** Class BWWF = Class B Warm Water Fishery, Δ criterion (referring to a change from ambient) is applied to the effects of a permitted discharge.

artificially regulated waters, the lowest flow conditions at which criteria must be met are the flow equal or exceeded 99% of the time on a yearly basis or another equivalent flow that has been agreed upon. In coastal and marine waters and for lakes the most severe hydrological condition is determined by MA DEP on a case-by-case basis.

The availability of appropriate and reliable scientific data and technical information is fundamental to the 305(b) reporting process. It is EPA policy (EPA Order 5360.1 CHG 1) that any organization, performing work for or on behalf of EPA, establishes a quality system to support the development, review, approval, implementation, and assessment of data collection operations. To this end, MA DEP describes its quality system in an EPA-approved Quality Management Plan to ensure that environmental data collected or compiled by MA DEP are of known and documented quality and are suitable for their intended use. For external sources of information, MA DEP requires the following: 1) an appropriate *Quality Assurance Project Plan* including a laboratory Quality Assurance /Quality Control (QA/QC) plan, 2) use of a state certified lab (certified in the applicable analysis), 3) data management QA/QC are described, and 4) the information be documented in a citable report.

EPA provides guidelines to the States for making their use support determinations (EPA 1997). The determination of whether or not a waterbody supports each of its designated uses is a function of the type(s), quality and quantity of available current information. Although data/information older than five years are usually considered "historical" and used for descriptive purposes, they can be utilized in the use support determination provided they are known to reflect the current conditions. While the water quality standards (Table 2) prescribe minimum water quality criteria to sustain the designated uses, numerical criteria are not available for every indicator of pollution. Best available guidance in the literature may be applied in lieu of actual numerical criteria (e.g., freshwater sediment data may be compared to *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* 1993 by D. Persaud, R. Jaagumagi and A. Hayton). Excursions from criteria due to solely "naturally occurring" conditions (e.g., low pH in some areas) do not constitute violations of the standards.

Each designated use within a given segment is individually assessed as 1*)* ***support***, 2) ***partial support***, or 3) ***non-support***. The term ***threatened*** is used when a use is fully supported but may not support the use within two years because of adverse pollution trends or anticipated sources of pollution. When too little current data/information exist or no reliable data are available the use is ***not assessed.*** In this report, however, if there is some indication that water quality impairment may exist, which is not "naturally occurring", the use is identified with an "Alert Status". Detailed guidance for assessing the status of each use follows in the Designated Uses Section of this report. It is important to note, however, that not all waters are assessed. Many small and/or unnamed ponds, rivers, and estuaries are currently ***unassessed***; the status of their designated uses has never been reported to EPA in the Commonwealth's 305(b) Report nor is information on these waters maintained in the Waterbody System (WBS) database.

DESIGNATED USES

The SWQS designate the most sensitive uses for which the surface waters of the Commonwealth shall be enhanced, maintained and protected. Each of these uses is briefly described below (MA DEP 1996):

- *AQUATIC LIFE* - suitable habitat for sustaining a native, naturally diverse, community of aquatic flora and fauna. Three subclasses of aquatic life are also designated in the standards for freshwater bodies: *Cold Water Fishery* - capable of sustaining a year-round population of cold water aquatic life, such as trout; *Warm Water Fishery* - waters that are not capable of sustaining a year-round population of cold water aquatic life; and *Marine Fishery* - suitable for sustaining marine flora and fauna.
- *FISH CONSUMPTION* - pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or for the recreational use of fish, other aquatic life or wildlife for human consumption.
- *DRINKING WATER* – is used to denote those waters used as a source of public drinking water. They may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). These waters are designated for protection as Outstanding Resource Waters under 314 CMR 4.04(3).
- *SHELLFISH HARVESTING* (in SA and SB segments) – Class SA waters in approved areas (Open Shellfish Areas) shellfish harvested without depuration shall be suitable for consumption; Class SB waters

in approved areas (Restricted Shellfish Areas) shellfish harvested with depuration shall be suitable for consumption.

- *PRIMARY CONTACT RECREATION* - suitable for any recreation or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water. These include, but are not limited to, wading, swimming, diving, surfing and water skiing.
- *SECONDARY CONTACT RECREATION* - suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities.
- *AESTHETICS* - all surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.
- *AGRICULTURAL AND INDUSTRIAL* - suitable for irrigation or other agricultural process water and for compatible industrial cooling and process water.

The guidance used to assess the *Aquatic Life, Fish Consumption, Drinking Water, Shellfishing, Primary* and *Secondary Contact Recreation* and *Aesthetics* uses follows. The status of the *Agricultural and Industrial Use* is not reported to EPA.

AQUATIC LIFE USE

This use is suitable for sustaining a native, naturally diverse, community of aquatic flora and fauna. The results of biological (and habitat), toxicological, and chemical data are integrated to assess this use. The nature, frequency, and precision of the MA DEP's data collection techniques dictate that a weight of evidence be used to make the assessment, with biosurvey results used as the final arbiter of borderline cases. The following chart provides an overview of the guidance used to assess the status (support, partial support, non-support) of the *Aquatic Life Use*:

Variable (#) - Indicates reference provided at the end of the designated use section	***Support*** – Data available clearly indicates support. Minor excursions from chemical criteria (Table 2) may be tolerated if the biosurvey results demonstrate support.	***Partial Support*** – Uncertainty about support in the chemical or toxicity testing data, or there is some minor modification of the biological community. Excursions not frequent or prolonged.	***Non-Support*** – There are frequent or severe violations of chemical criteria, presence of acute toxicity, or a moderate or severe modification of the biological community.
BIOLOGY			
Rapid Bioassessment Protocol (RBP) II or III (4)	Non-Impaired	Slightly Impaired	Moderately or Severely Impaired
Fish Community (4)	Best Professional Judgment (BPJ)	BPJ	BPJ
Habitat and Flow (4)	BPJ	BPJ	Dewatered streambed due to artificial regulation or channel alteration
Macrophytes (4)	BPJ	Exotic plant species present, but not dominant, BPJ	Exotic plant species dominant, BPJ
Plankton/ Periphyton (4)	No algal blooms	Occasional algal blooms	Persistent algal blooms
TOXICITY TESTS			
Water Column/Ambient (4)	>75% survival either 48 hr or 7-day exposure	>50 - ≤75% survival either 48 hr or 7-day exposure	≤50% survival either 48 hr or 7-day exposure
Effluent (4)	Meets permit limits	(NOTE: if limit is not met, the stream is listed as threatened for 1.0 river mile downstream from the discharge.)	
Sediment (4)	>75% survival	>50 - ≤75% survival	≤50% survival
CHEMISTRY- WATER			
DO (3, 6)	Criteria (Table 2)	Criteria exceeded in 11-25% of measurements.	Criteria exceeded >25% of measurements.
pH (3, 6)	Criteria (Table 2)	Criteria exceeded in 11-25% of measurements.	Criteria exceeded >25% of measurements.
Temperature (3, 6) [1]	Criteria (Table 2) [1]	Criteria exceeded in 11-25% of measurements.	Criteria exceeded >25% of measurements.
Turbidity (4)	Δ 5 NTU due to a discharge	BPJ	BPJ
Suspended Solids (4)	25 mg/L max., Δ10 mg/L due to a discharge	BPJ	BPJ
Nutrients (3) Phosphate-P (4)	Table 2, (Site-Specific Criteria; Maintain Balanced Biocommunity, no pH/DO violations)	BPJ	BPJ
Toxic Pollutants (3, 6) Ammonia-N (3, 4) [2] Chlorine (3, 6) [3]	Criteria (Table 2) 0.254 mg/L NH_3-N [2] 0.011 mg/L TRC [3]	BPJ	Criterion is exceed in > 10% of samples.
CHEMISTRY – SEDIMENT			
Toxic Pollutants (5) [4]	≤ Low Effect Level (L-EL) [4]	One pollutant between L-EL and Severe Effect Level (S-EL)	One pollutant ≥ S-EL (severe)
Nutrients (5)	≤ L-EL	Between L-EL and S-EL	≥ S-EL
Metal Normalization to Al or Fe (4)	Enrichment Ratio ≤ 1	Enrichment Ratio >1 but ≤10	Enrichment Ratio ≥10
CHEMISTRY- EFFLUENT			
Compliance with permit limits (4)	In-compliance with all limits	NOTE: If the facility does not meet their permit limits, the information is used to threaten one river mile downstream from the discharge.	
CHEMISTRY-TISSUE			
PCB – whole fish (1)	≤500 µg/kg wet weight	BPJ	BPJ
DDT (2)	≤14.0 µg/kg wet weight	BPJ	BPJ
PCB in aquatic tissue (2)	≤0.79 ng TEQ/kg wet weight	BPJ	BPJ

[1] maximum daily mean T in a month (minimum six measurements evenly distributed over 24-hours) less than criterion, [2] Ammonia levels for pH of 9.0, actual "criterion" varies with pH and is evaluated case-by-case. [3] The minimum quantification level for TRC is 0.05 mg/L. [4] For the purpose of this report, the S-EL for total PCB in sediment (which varies with TOC content) with 1% TOC is 5.3 ppm while a sediment sample with 10% TOC is 53 ppm.

Note: National Academy of Sciences/National Academy of Engineering (NAS/NAE) guideline for maximum organochlorine concentrations (i.e., total PCB) in fish tissue for the protection of fish-eating wildlife is 500µg/kg wet weight (ppb, not lipid-normalized). PCB data (tissue) in this report are presented in µg/kg wet weight (ppb) and are not lipid-normalized to allow for direct comparison to the NAS/NAE guideline.

FISH CONSUMPTION USE

Pollutants shall not result in unacceptable concentrations in edible portions of marketable fish or for the recreational use of fish, other aquatic life or wildlife for human consumption. The assessment of this use is made using the most recent list of Fish Consumption Advisories issued by the Massachusetts Executive Office of Health and Human Services, Department of Public Health (MDPH), Bureau of Environmental Health Assessment (MDPH 2001a). The MDPH list identifies waterbodies where elevated levels of a specified contaminant in edible portions of freshwater species poses a health risk for human consumption. Hence, the Fish Consumption Use is assessed as non-support in these waters.

In July 2001, MDPH issued new consumer advisories on fish consumption and mercury contamination. The MDPH "...is advising pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age to refrain from eating the following marine fish; shark, swordfish, king mackerel, tuna steak and tilefish. In addition, MDPH is expanding its previously issued statewide fish consumption advisory which cautioned pregnant women to avoid eating fish from all freshwater bodies due to concerns about mercury contamination, to now include women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age (MDPH 2001b)."

Additionally, MDPH "...is recommending that pregnant women, women of childbearing age who may become pregnant, nursing mothers and children under 12 years of age limit their consumption of fish not covered by existing advisories to no more than 12 ounces (or about 2 meals) of cooked or uncooked fish per week. This recommendation includes canned tuna, the consumption of which should be limited to 2 cans per week. Very small children, including toddlers, should eat less. Consumers may wish to choose to eat light tuna rather than white or chunk white tuna, the latter of which may have higher levels of mercury (MDPH 2001b)."

MDPH's statewide advisory does not include fish stocked by the state Division of Fisheries and Wildlife or farm-raised fish sold commercially. Because of the statewide advisory, however, no waters can be assessed as support or partial support for the *Fish Consumption Use*. The following is an overview of the guidance used to assess the status (support, partial support, non-support) of the *Fish Consumption Use*.

Variable (#) - Indicates reference provided at the end of the designated use section	***Support*** – No restrictions or bans in effect	***Partial Support*** – A "restricted consumption" fish advisory is in effect for the general population or a sub-population that could be at potentially greater risk (e.g., pregnant women, and children	***Non-Support*** – A "no consumption" advisory or ban in effect for the general population or a sub-population for one or more fish species; or there is a commercial fishing ban in effect
MDPH Fish Consumption Advisory List (8,12)	Not applicable, precluded by statewide advisory (Hg)	Not applicable	Waterbody on MDPH Fish Consumption Advisory List

Other statewide advisories that MDPH has previously issued and are still in effect are as follows (MDPH 2001b):

1. Due to concerns about chemical contamination, primarily from polychlorinated biphenyl compounds (PCB) and other contaminants, no individual should consume lobster tomalley from any source. Lobster tomalley is the soft green substance found in the tail and body section of the lobster.

2. Pregnant and breastfeeding women and those who are considering becoming pregnant should not eat bluefish due to concerns about PCB contamination in this species.

DRINKING WATER USE

The term *Drinking Water Use* denotes those waters used as a source of public drinking water. These waters may be subject to more stringent regulation in accordance with the Massachusetts Drinking Water Regulations (310 CMR 22.00). They are designated for protection as Outstanding Resource Waters (ORW) in 314 CMR 4.04(3). MA DEP's Drinking Water Program (DWP) has primacy for implementing the provisions of the federal Safe Drinking Water Act (SDWA). Except for suppliers with surface water sources for which a waiver from filtration has been granted (these systems also monitor surface water quality) all public drinking water supplies are monitored as finished water (tap water). Monitoring includes the major categories of contaminants established in the SDWA: bacteria, volatile and synthetic organic compounds, inorganic compounds and radionuclides. The DWP maintains current drinking supply monitoring data. The status of the supplies is currently reported on a statewide basis to EPA in the 305(b) report. Below is EPA's guidance to assess the status (support, partial support, non-support) of the drinking water use.

Variable (#) - Indicates reference provided at the end of the designated use section	***Support*** – No closures or advisories (no contaminants with confirmed exceedances of maximum contaminant levels, conventional treatment is adequate to maintain the supply).	***Partial Support*** – Is one or more advisories or more than conventional treatment is required	***Non-Support*** – One or more contamination-based closures of the water supply
Drinking Water Program (DWP) Evaluation	See note below	See note below	See note below

Note: While this use is not assessed in this report, information on drinking water source protection and finish water quality is available at http://www.state.ma.us/dep/brp/dws/dwshome.htm and from the Merrimack River Basin public water suppliers.

SHELLFISHING USE

This use is assessed using information from the Department of Fisheries, Wildlife and Environmental Law Enforcement's Division of Marine Fisheries (DMF). A designated shellfish growing area is an area of potential shellfish habitat. Growing areas are managed with respect to shellfish harvest for direct human consumption, and comprise at least one or more classification areas. The classification areas are the management units and they range from approved to prohibited (listed below) with respect to shellfish harvest. Shellfish areas under management closures are *not assessed.*

Variable (#) - Indicates reference provided at the end of the designated use section	***Support –*** SA Waters—Approved[1] SB Waters— Approved[1], Conditionally Approved[2] or Restricted[3]	***Partial Support –*** SA Waters— Conditionally Approved[2], Restricted[3], or Conditionally Restricted[4] SB Waters—Conditionally Restricted[4]	***Non Support –*** SA Waters—Prohibited[5] SB Waters— Prohibited[5]
Division of Marine Fisheries Shellfish Project Classification Area Information (11)	Reported by DMF	Reported by DMF	Reported by DMF

[1] **Approved** - "...open for harvest of shellfish for direct human consumption subject to local rules and regulations..." An approved area is open all the time and closes only due to hurricanes or other major coastwide events.

[2] **Conditionally Approved** - "...subject to intermittent microbiological pollution..." During the time the area is open, it is "...for harvest of shellfish for direct human consumption subject to local rules and regulations..." A conditionally approved area is closed some of the time due to runoff from rainfall or seasonally poor water quality. When open, shellfish harvested are treated as from an approved area.

[3] **Restricted** - area contains a "limited degree of pollution." It is open for "harvest of shellfish with depuration subject to local rules and state regulations" or for the relay of shellfish. A restricted area is used by DMF for the relay of shellfish to a less contaminated area.

[4] **Conditionally Restricted** - "...subject to intermittent microbiological pollution..." During the time area is restricted, it is only open for "the harvest of shellfish with depuration subject to local rules and state regulations." A conditionally restricted area is closed some of the time due to runoff from rainfall or seasonally poor water quality. When open, only soft-shell clams may be harvested by specially licensed diggers (Master/Subordinate Diggers) and transported to the DMF Shellfish Purification Plant for depuration (purification).

[5] **Prohibited** - Closed for harvest of shellfish.

PRIMARY CONTACT RECREATIONAL USE

This use is suitable for any recreational or other water use in which there is prolonged and intimate contact with the water with a significant risk of ingestion of water (1 April to 15 October). These include, but are not limited to, wading, swimming, diving, surfing and water skiing. The chart below provides an overview of the guidance used to assess the status (support, partial support, non-support) of the *Primary Contact Use*.

Variable (#) - Indicates reference provided at the end of the designated use section	***Support*** – Criteria are met, no aesthetic conditions that preclude the use	***Partial Support*** – Criteria exceeded intermittently (neither frequent nor prolonged), marginal aesthetic violations	***Non-Support*** – Frequent or prolonged violations of criteria, formal bathing area closures, or severe aesthetic conditions that preclude the use
Fecal Coliform Bacteria (3, 9) *	Criteria met OR Dry Weather Guidance <5 samples--≤400/100mL maximum Wet Weather Guidance Dry weather samples meet and wet samples ≤2000/100mL	Guidance exceeded in 11-25% of the samples OR Wet Weather Dry weather samples meet and wet samples >2000/100mL	Guidance exceeded in > 25% of the samples
pH (3, 6)	Criteria exceeded in ≤10 % of the measurements	Criteria exceeded in 11-25% of the measurements	Criteria exceeded in >25% of the measurements
Temperature (3)	Criteria met	Criteria exceeded 11-25% of the time	Criteria exceeded 25% of the time
Color and Turbidity (3, 6)	BPJ, Δ 5 NTU (due to a discharge) exceeded in ≤10 % of the measurements	BPJ, Guidance exceeded in 11-25% of the measurements	BPJ, Guidance exceeded in >25% of the measurements
Secchi disk depth (10) **	Lakes - ≥1.2 meters (≥ 4')	Infrequent excursions from the guidance	Frequent and/or prolonged excursions from the guidance
Oil & Grease (3)	Criteria met	BPJ, criteria exceeded 11-25% of the time	BPJ, criteria exceeded >25% of the time
Aesthetics (3) Biocommunity (4)**	No nuisance organisms that render the water aesthetically objectionable or unusable, BPJ; Cover of macrophytes < 50% within any portion of the lake area at maximum extent of growth.	BPJ, Cover of macrophytes 50-75% within any portion of the lake area at maximum extent of growth.	BPJ, Cover of macrophytes >75 within any portion of the lake area at maximum extent of growth.

Note: Excursions from criteria due to natural conditions are not considered impairment of use.

* Fecal coliform bacteria interpretations require additional information in order to apply this use assessment guidance. Small/limited datasets require an evaluation of survey conditions (i.e., interpretation of the amount of precipitation received in the subject region immediately prior to sampling and streamflow conditions) to determine whether the fecal coliform bacteria results are representative of dry or wet weather/storm water runoff conditions. When larger data sets are available, the frequency of standards/guidance exceedances is calculated.

**Any portion of a lake exhibiting impairment of the *Primary Contact Recreation Use* (swimmable) because of macrophyte cover and/or transparency (Secchi disk depth) is assessed as either partial or non-support. If no fecal coliform bacteria data are available and the lake (entirely or in part) met the transparency (Secchi disk depth) and aesthetics guidance, this use is not assessed.

SECONDARY CONTACT RECREATIONAL USE

This use is suitable for any recreation or other water use in which contact with the water is either incidental or accidental. These include, but are not limited to, fishing, boating and limited contact incident to shoreline activities. Following is an overview of the guidance used to assess the status (support, partial support, non-support) of the *Secondary Contact Use*.

Variable (#) - Indicates reference provided at the end of the designated use section	***Support*** – Criteria are met, no aesthetic conditions that preclude the use	***Partial Support*** – Criteria exceeded intermittently (neither frequent nor prolonged), marginal aesthetic violations	***Non-Support*** – Frequent or prolonged violations of criteria, or severe aesthetic conditions that preclude the use
Fecal Coliform Bacteria (4) *	Dry Weather Guidance <5 samples--≤2000 cfu/100mL maximum >5 samples--≤1000 cfu/100mL geometric mean ≤ 10% samples ≥2000 cfu/100mL Wet Weather Guidance Dry weather samples meet and wet samples ≤4000 cfu/100mL	Wet Weather Guidance Dry weather samples meet and any wet samples >4000 cfu/100mL	Criteria exceeded in dry weather
Oil & Grease (3)	Criteria met	Criteria exceeded 11-25% of the time, BPJ	Criteria exceeded >25% of the time, BPJ
Aesthetics (3) Biocommunity (4) **	No nuisance organisms that render the water aesthetically objectionable or unusable, BPJ; Cover of macrophytes < 50% within any portion of the lake area at maximum extent of growth.	BPJ, Cover of macrophytes 50-75% within any portion of the lake area at maximum extent of growth.	BPJ, Cover of macrophytes >75 within any portion of the lake area at maximum extent of growth.

Note: Excursions from criteria due to natural conditions are not considered impairment of use.

* Fecal coliform bacteria interpretations require additional information in order to apply this use assessment guidance. Small/limited datasets require an evaluation of survey conditions (i.e., interpretation of the amount of precipitation received in the subject region immediately prior to sampling and streamflow conditions) to determine whether the fecal coliform bacteria results are representative of dry or wet weather/storm water runoff conditions. When larger data sets are available, the frequency of standards/guidance exceedances is calculated.

** In lakes if no fecal coliform data are available, macrophyte cover is the only criterion used to assess the *Secondary Contact Recreational Use*.

For the *Primary* and *Secondary Contact Recreational* uses the following steps are taken to interpret the fecal coliform bacteria results:

1. Identify the range of fecal coliform bacteria counts,
2. Calculate the geometric mean (monthly, seasonally, or on dataset), (Note: the geometric mean is only calculated on datasets with >5 samples collected within a 30-day period.)
3. Calculate the % of sample results exceeding 400 cfu/100mL,
4. Determine if the samples were collected during wet or dry weather conditions (review precipitation and streamflow data)
   - Dry weather can be defined as: No/trace antecedent (to the sampling event) precipitation that causes more than a slight increase in stream flow.
   - Wet weather can be defined as: Precipitation antecedent to the sampling event that results in a marked increase in stream flow.
5. Apply the following to interpret dry weather data:
   - ≤10% of the samples exceed criteria (step 2 and 3, above) - assess as Support,
   - 11-25% of the samples exceed criteria (step 2 and 3, above) - asses as Partial Support,
   - >25% of the samples exceed criteria (step 2 and 3, above) - assess as Non-Support.
6. Apply the following to interpret wet weather data:
   - Dry weather samples meet criteria and all wet samples ≤4000 cfu/100mL - assess as Support,
   - Dry weather samples meet criteria and any wet samples >4000 cfu/100mL - assess as Partial Support.

AESTHETICS USE

All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life. The aesthetic use is closely tied to the public health aspects of the recreational uses (swimming and boating). Below is an overview of the guidance used to assess the status (support, partial support, non-support) of the *Aesthetics Use*.

Variable (#) - Indicates reference provided at the end of the designated use section	***Support*** – 1. No objectionable bottom deposits, floating debris, scum, or nuisances; 2. No objectionable odor, color, taste or turbidity, or nuisance aquatic life	***Partial Support*** – Objectionable conditions neither frequent nor prolonged	***Non-Support*** – Objectionable conditions frequent and/or prolonged
Aesthetics (3)* Visual observation (4)	Criteria met	BPJ (spatial and temporal extent of degradation)	BPJ (extent of spatial and temporal degradation)

* For lakes, the aesthetic use category is generally assessed at the same level of impairment as the more severely impaired recreational use category (*Primary* or *Secondary Contact*).

Designated Use References

1. Coles, J.C. 1998.*Organochlorine Compounds in Fish Tissue from the Connecticut, Housatonic and Thames River Basins Study Unit, 1992-94.* National Water-Quality Assessment Program. U.S. Department of the Interior, U.S. Geological Survey. Marlborough, MA.
2. Environment Canada. 04 November 1999. Canadian Environmental Quality Guidelines. [Online]. Environment Canada. http://www.ec.gc.ca/ceqg-rcqe/tistbl_e.doc [28 September 1998].
3. MA DEP. 1996. (Revision of 1995 report). *Massachusetts surface water quality standards.* Massachusetts Department of Environmental Protection, Division of Water Pollution Control, Technical Services Branch. Westborough, MA (Revision of 314 CMR 4.00, effective June 23, 1996).
4. MA DEP. 1999. Open File. *Department of Watershed Management 305(b) Assessment Guidance.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA
5. Persaud, D., R. Jaagumagi, and A. Hayton. 1993. *Guidelines for the protection and management of aquatic sediment quality in Ontario.* Water Resources Branch, Ontario Ministry of the Environment. Queen's Printer for Ontario. Canada.
6. EPA. 1997. Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) Reports) and Electronic Updates: Supplement. Assessment and Watershed Protection Division (4503F), Office of Wetlands, Oceans and Watersheds, Office of Water, U.S. Environmental Protection Agency. Washington, DC.
7. EPA. 19 November 1999. Federal Register Document. [Online]. United States Environmental Protection Agency. http://www.epa.gov/fedrgstr/EPA-WATER/1998/December/Day-10/w30272.htm.
8. MDPH. 1999. *Freshwater Fish Consumption Advisory List.* The Commonwealth of Massachusetts, Bureau of Environmental Health Assessment. Boston, MA.
9. Kimball, W.A., 1996. Memorandum to 305(b) Committee. *Re: Small data sets/ wet weather data.* Massachusetts Department of Environmental Protection, Office of Watershed Management. Grafton, MA.
10. MDPH. 1969. *Article 7 Regulation 10.2B of the State Sanitary Code.* Commonwealth of Massachusetts. Department of Public Health. Boston, MA.
11. Churchill, N. 1999. Personal Communication. *Shellfish Project Classification Area Information as of 1 January 1999.* Department of Fisheries, Wildlife, and Environmental Law Enforcement, Division of Marine Fisheries. Pocasset, MA.
12. MDPH. 2001b. *Public Health Statewide Fish Consumption Advisory.* Massachusetts Department of Public Health. Boston. MA.

MERRIMACK RIVER BASIN DESCRIPTION AND CLASSIFICATION

DESCRIPTION

The Merrimack River drainage area is the fifth largest in New England encompassing a total of 5,014 square miles in New Hampshire and Massachusetts (Figure 6). As a New England interstate basin, it is surpassed only by the Connecticut River. The mainstem Merrimack River is formed in central New Hampshire by the confluence of the Pemigewasset and Winnipesaukee rivers. The mainstem flows southward through central New Hampshire (approximately 78 miles) and enters Massachusetts. Nearly one quarter of the Merrimack's drainage area (1,200 square miles) lies within northeastern Massachusetts. In Massachusetts, the Merrimack River Basin is bordered by the Parker River Basin to the east, the Ipswich River Basin to the southeast, the Shawsheen River Basin to the south, the Concord River Basin to the southwest and the Nashua River Basin to the west while the northern portion of the basin is bordered by the state of New Hampshire (Figure 7).

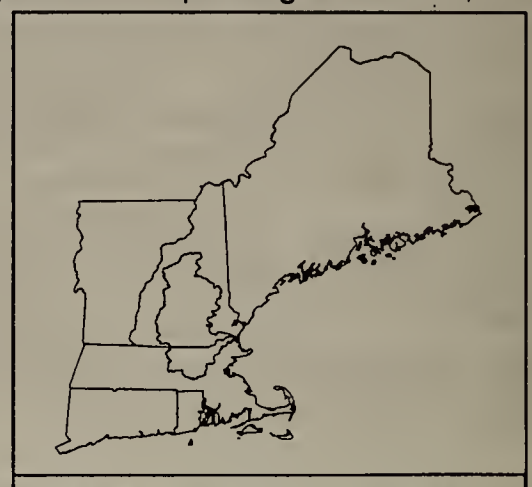


Figure 6. Merrimack River Basin Location (New England).

Once in Massachusetts, the Merrimack River flows generally southeast for about six miles then turns northeast near the city of Lowell, Massachusetts. The Merrimack River continues to flow northeast towards the city of Newburyport where it then empties into the Atlantic Ocean. The Merrimack River drops 90 feet in elevation along its 53-mile course through Massachusetts to the Atlantic Ocean. This elevation change includes the two major dams in Lawrence and Lowell, the Pawtucket and Essex dams. The river is tidal downstream from its confluence with Creek Brook in Haverhill (the lower 25 mile linear reach with an area of approximately 6.97 square miles). Excluding the Nashua, Concord and Shawsheen rivers (treated as separate major watersheds in Massachusetts), large tributaries to the Merrimack River in Massachusetts include: Stony Brook and the Spicket, Little and Powwow rivers.

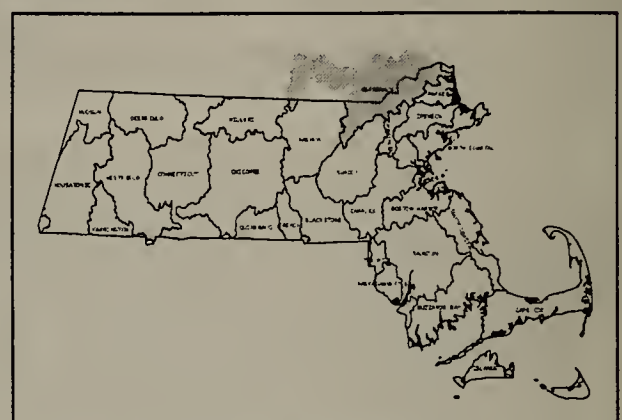


Figure 7. Lower Merrimack River Basin Drainage Area.

The United States Geological Survey (USGS) maintains one gaging station (No. 01100000) on the mainstem Merrimack River in Massachusetts at Lowell (downstream from the confluence of the Concord River). This gage has provided continuous daily discharge records since 1923. Major canal systems are also present in Lawrence and Lowell. The mean annual flow of the Merrimack River at the Lowell gage (drainage area = 4,635 square miles) is 7,632 cubic feet per second (cfs) (Flanagan *et al.* 1999). The estimated seven-day mean low flow with a recurrence interval of 10 years (7Q10) is 930 cfs at this gage (Garabedian 2001).

In Massachusetts, 24 communities lie wholly or in part within the basin boundaries: Amesbury, Andover, Ayer, Boxford, Boxborough, Chelmsford, Dracut, Dunstable, Groton, Groveland, Harvard, Haverhill, Lawrence, Littleton, Lowell, Merrimac, Methuen, Newburyport, North Andover, Salisbury, Tewksbury, Tyngsborough, Westford, and West Newburyport. The three major cities along the Merrimack River in Massachusetts are Lowell, Lawrence, and Haverhill. As historic industrial centers, these cities were once sources of severe pollution from untreated municipal and industrial wastewater discharges. Today, secondary wastewater treatment facilities operate in Lowell, Lawrence, and Haverhill, as well as in Amesbury, Merrimac, and Newburyport. Water quality problems are still evident in the watershed due in part to combined sewer overflows (CSO) in Lowell, Lawrence, and Haverhill; various nonpoint sources of pollution; and smaller industrial discharges.

There are 79 named streams in the Merrimack River Basin (exclusive of the Nashua, Concord and Shawsheen River Basins) that have been assigned Stream and River Information System (SARIS) code numbers (Halliwell *et al.* 1982). These streams and rivers flow an estimated 225.1 miles. A total of 96 lakes, ponds or impoundments (the term "lakes" will hereafter be used to include all) have been identified and assigned Pond and Lake Information System (PALIS) code numbers in the Merrimack River Basin (Ackerman 1989 and MA DEP 2001a). The total surface area of the Merrimack River Basin lakes is 4,803 acres. [Note: A variety of sources have been used to determine the river length and lake area including the WBS database, diagnostic/feasibility studies, and 1:25,000 Massachusetts Geographic Information System (MassGIS) datalayers. Future plans are to base all size determinations on the most accurate MassGIS datalayer available.] The total area of estuarine waters in the Merrimack River Basin is approximately 7.32 square miles. [Note: A variety of sources have been used to determine the river length, and pond and estuarine area including the WBS database, diagnostic/feasibility studies, and 1:25,000 MassGIS datalayers. Future plans are to base all size determinations on the most accurate MassGIS datalayers available.]

CLASSIFICATION

Consistent with the National Goal Uses of "fishable and swimmable waters", the classification of waters in the Merrrimack River Basin according to the SWQS, include the following (MA DEP 1996):

"Class A – These waters are designated as a source of public water supply. To the extent compatible with its use they shall be an excellent habitat for fish, other aquatic life and wildlife, and suitable for primary and secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters (ORW) under 314 CMR 4.04(3)" (Rojko et al 1995).

Class A Public Water Supplies in the Merrimack River Basin:

- Lake Attitash, source to outlet in Amesbury and those tributaries thereto
- Tuxbury Pond, source to outlet in Amesbury and those tributaries thereto
- Powwow River, outlet of Tuxbury Pond to inlet Lake Gardner
- Millvale Reservoir, source to outlet in Haverhill and tributaries thereto
- Kenoza Lake, source to outlet in Haverhill and those tributaries thereto
- Crystal Lake, source to outlet in Haverhill and those tributaries thereto
- Haggetts Pond, source to outlet in Andover and those tributaries thereto
- Fish Brook, entire length and those tributaries thereto
- Lake Cochichewick, source to outlet in North Andover and those tributaries thereto
- Upper and Lower Artichoke Reservoir, source to outlet in West Newbury and those tributaries thereto
- Unnamed Reservoir (Indian Hill Reservoir), source to outlet in West Newbury and those tributaries thereto
- Chadwicks Pond (Little Pond), source to outlet in Haverhill and those tributaries thereto
- Hoveys Pond (Mitchell Pond, Johnson Pond), source to outlet in Boxford and those tributaries thereto
- Johnsons Pond, source to outlet in Groveland and those tributaries thereto
- Lake Pentucket (Round Pond), source to outlet in Haverhill and those tributaries thereto

In accordance with the SWQS, all Class A waters are designated as ORWs (Rojko *et al.* 1995). The designation of ORW is applied to those waters with exceptional socio-economic, recreational, ecological and/or aesthetic values. ORWs have more stringent requirements than other waters because the existing use is so exceptional or the perceived risk of harm is such that no lowering of water quality is permissible. ORWs include certified vernal pools; and all designated *Class A Public Water Supplies*; may include surface waters found in National Parks, State Forests and Parks, Areas of Critical Environmental Concern (ACEC); and those protected by special legislation (MA DEM 1993). Wetlands that border ORWs are designated as ORWs to the boundary of the defined area.

- The Massachusetts Secretary of Environmental Affairs has formally designated a small portion of the Merrimack River Basin as part of the Parker River/Essex Bay ACEC due to its unique environmental characteristics, including the ability to support rare or endangered species (MA DEM 1993). The Merrimack River estuary in the vicinity of Chaces Island and the Plum Island River are encompassed in this ACEC.

"Class B – These waters are designated as habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Where designated they shall be suitable as a source of water supply with appropriate treatment. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value."

Class B Cold Water Fisheries in the Merrimack River Basin:

- Beaver Brook, state line to confluence
- Cobbler Brook, entire length

Class B Warm Water Fisheries in the Merrimack River Basin (other restrictions as noted):

- Merrimack River, State Line to Pawtucket Dam (Treated Water Supply)
- Merrimack River, Pawtucket Dam to Essex Dam, Lawrence (Treated Water Supply, CSO)
- Merrimack River, Essex Dam, Lawrence to Creek Brook, Haverhill (CSO)
- Stony Brook, entire length
- Spicket River, State Line to confluence with the Merrimack River
- Little River, State Line to confluence with the Merrimack River
- Powwow River, Outlet Lake Gardner to tidal portion

"Class SA – These waters are designated as an excellent habitat for fish, other aquatic life and wildlife and for primary and secondary recreation. In approved areas they shall be suitable for shellfish harvesting without depuration (Open Shellfishing Areas). These waters shall have excellent aesthetic value."

Class SA Open Shellfishing Areas in the Merrimack River Basin:

- The Basin in the Merrimack River Estuary, Newbury and Newburyport
- Plum Island River, entire length (ORW)
- Plum Island Sound (ORW)
- Plumbush Creek, Little Pine Island Creek, Pine Island Creek and Jericho Creek (ORW)

Note: Plum Island River south of the "High Sandy" sand bar (slightly north of the confluence with Pine Island Creek) to the confluence with Plum Island Sound drains south into the Parker River Basin/Plum Island Sound Coastal Drainage Area. Pine Island Creek and Jericho Creek also drain to the Parker River Basin/Plum Island Sound Coastal Drainage Area.

Class SB Restricted Shellfishing Areas in the Merrimack River Basin :

- Merrimack River, from Creek Brook, Haverhill to Altantic Ocean (CSO)
- Powwow River, tidal portion

Unlisted waters not otherwise designated in the SWQS are designated *Class B, High Quality Water*. According to the SWQS, where fisheries designations are necessary, they shall be made on a case-by-case basis.

SUMMARY OF EXISTING CONDITIONS AND PERCEIVED PROBLEMS

The CWA section 303(d) requires states to identify those waterbodies that are not meeting SWQS. The following waterbodies in the Merrimack River Basin, identified in Table 3, are on the 1998 Massachusetts Section 303(d) list of waters (MA DEP 1999a):

Table 3. 1998 303(d) List of Waters, Merrimack River Basin.

Name	Waterbody Identification Code (WBID)	Location	Cause of Impairment
Lake Attitash	MA84002	Amesbury/Merrimac	Noxious aquatic plants
Flint Pond	MA84012	Tyngsborough	Metals, Noxious aquatic plants
Forest Lake	MA84014	Methuen	Noxious aquatic plants
Long Pond	MA84032	Dracut/Tyngsborough	Noxious aquatic plants
Mill Pond	MA84038	Littleton	Noxious aquatic plants
Mill Pond	MA84039	West Newbury	Nutrients, Siltation, Noxious aquatic plants
Newfield Pond	MA84046	Chelmsford	Organic enrichment/Low DO
Mill Pond	MA84081	Littleton	Noxious aquatic plants
Knops Pond/Lost Lake	MA84084	Groton	Noxious aquatic plants
Massapoag Pond	MA84087	Dunstable/Groton/Tyngsborough	Organic enrichment/Low DO
Ward Pond	MA84096	Ashburnham	Organic enrichment/Low DO
Plum Island River[1]	MA84A-23 (changed to MA84A-27 and MA91-15)	From Chaces Island to mouth at Plum Island Sound	Pathogens
Merrimack River	MA84A-01	New Hampshire state line to Pawtucket Dam, Lowell	Pathogens
	MA84A-02	Pawtucket Dam to Duck Island, Lowell	Nutrients, Pathogens
	MA84A-03	Duck Island, Lowell to Essex Dam, Lawrence	Nutrients, Pathogens
	MA84A-04	Essex Dam, Lawrence to confluence with Creek Brook, Haverhill	Nutrients, Pathogens
	MA84A-05	Confluence Creek Brook, Haverhill to confluence Indian River, West Newbury	Unionized Ammonia, Pathogens
	MA84A-06	Confluence Indian River, West Newbury to mouth at Atlantic Ocean, Newburyport/Salisbury	Pathogens
Powwow River	MA84A-08	(no descriptor given)	Pathogens
Spicket River	MA84A-10	Massachusetts/New Hampshire state line Methuen to confluence with Merrimack River, Lawrence	Metals, Nutrients, Pathogens
Beaver Brook	MA84A-11	Massachusetts/New Hampshire state line Dracut to confluence with Merrimack River, Lowell	Pathogens
Stony Brook	MA84B-03	Concord Road (Route 225) to Chamberlin Road, Westford	pH, Organic enrichment/Low DO, Pathogens, Turbidity
Stony Brook	MA84B-04	Chamberlin Road to confluence with Merrimack River	Nutrients, pH, Pathogens

Table 3. 1998 303(d) List of Waters, Merrimack River Basin. (Continued)

Name	Waterbody Identification Code (WBID)	Location	Cause of Impairment
Beaver Brook	MA84B-02	Outlet Mill Pond to inlet Forge Pond	Nutrients, pH, Organic enrichment/Low DO, Pathogens, Suspended solids
Unnamed Tributary	MA84B-01	Also know as outlet of "Wolf Swamp" and "Mill Brook" to inlet of Mill Pond	Nutrients, pH, Organic enrichment/Low DO, Pathogens, Suspended solids
Plum Island Sound[1]	MA84A-24 (changed to MA91-12)	(Includes Ipswich Bay)	Pathogens
Frye Pond*, **	MA84082	Andover	Noxious aquatic Plants
Powwow River*	MA84A-07	Inlet Lake Gardner to tidal portion, Amesbury	Pathogens, Suspended solids, Noxious aquatic plants, Turbidity
Back River*	MA84A-16	New Hampshire state line to confluence with Powwow River, Amesbury	Siltation, Pathogens, Turbidity
Cobbler Brook*	MA84A-22	Headwaters to confluence with Merrimack River, Merrimac	Unknown toxicity
Johnson Creek*	MA84A-15	Headwaters to confluence with Merrimack River, Groveland	Siltation
Little River*	MA84A-09	New Hampshire state line to confluence with Merrimack River, Haverhill	Pathogens
Bare Meadow Brook*	MA84A-18	Headwaters to confluence with Merrimack River, Methuen	Siltation, Organic enrichment/Low DO, Pathogens, Turbidity
Trull Brook*	MA84A-14	Source to confluence with Merrimack River, Tewksbury	Unknown Toxicity
Richardson Brook*	MA84A-12	Headwaters to confluence with Merrimack River, Dracut	Other habitat alterations, Noxious aquatic plants
Black Brook*	MA84A-17	Headwaters, Chelmsford to confluence with Merrimack River, Lowell	Unknown toxicity, Siltation, Organic enrichment/Low DO, Pathogens
Deep Brook*	MA84A-21	Headwaters, Dunstable to confluence with Merrimack River, Chelmsford	Unknown toxicity, Siltation, Organic enrichment/Low DO, Pathogens
Lawrence Brook*	MA84A-20	Headwaters to confluence with Merrimack River, Tyngsborough	Unknown toxicity
Martins Pond Brook*	MA84A-19	Outlet Martins Pond to inlet Lost Lake, Groton	Siltation, Organic enrichment/Low DO, Turbidity

[1] Reporting for the southern portion of the Plum Island River (south of the "High Sandy" sand bar -- near the inlet to Pine Island Creek, to the confluence with Plum Island Sound) and Plum Island Sound has been changed from the Merrimack River Basin to the Parker River Basin/ Plum Island Sound Coastal Drainage Area with new WBID's – MA91-15 and MA91-12, respectively. Current information on water quality conditions for these segments can be found in the Parker River Watershed 1999 Water Quality Assessment Report (Weinstein and Connors 2001). The northern portion of Plum Island River (from the Merrimack River Estuary to the "High Sandy" sand bar is now segment MA84A-27.

*needs confirmation (additional data collection is necessary to confirm the presence of impairment)

** Frye Pond was incorrectly listed in the Merrimack River Basin. It is actually a 303(d) listed lake located within the Ipswich River Basin.

Water quality problems in the Merrimack River are due in part to combined sewer overflows (CSO) in two communities in New Hampshire (Manchester and Nashua) and three in Massachusetts (Lowell, Lawrence and Haverhill). According to the New Hampshire 1998 305(b) Report, Manchester is under a consent order to implement Phase I of their facility plan to eliminate approximately 50% of the CSO by 2010 (NH DES 2001). Nashua is also under an administrative order to eliminate their CSOs (separation) by 2020. The Massachusetts communities are also in the midst of developing long-term control plans and are currently implementing "Nine Minimum Controls" programs to mitigate the frequency, duration, and impacts of their CSO discharges.

Within the last decade, the northeastern United States has been identified as having elevated rates of mercury deposition from the atmosphere and high levels of mercury contamination in non-commercial freshwater fish (Tatsutani 1998). Mercury is a trace metal that exists in the earth's crust. It is a toxicant that, once mobilized in the environment, can be transformed into methylmercury -- a particularly toxic form that can bioaccumulate in fish. Currently, there are 17 lakes in the Merrimack River Basin, as well as a portion of the mainstem Merrimack River, for which DPH has issued fish consumption advisories because of elevated levels of mercury. The most recent MDPH Fish Consumption List recommends the following for waterbodies in the Merrimack River Basin (MDPH 2001a):

Chadwicks Pond (Little Pond) in Haverhill/Boxford, Kenoza Lake in Haverhill and Lake Pentucket (Round Pond) in Haverhill:

1. "The general public should not consume any fish from this waterbody."

Lake Cochichewick in North Andover, Forest Lake (Harris or South Pond) in Methuen, Haggetts Pond in Andover, Johnsons Pond in Groveland/Boxford, Lake Saltonstall in Haverhill, Newfield Pond (Freeman or Crystal Lake) in Chelmsford and Stevens Pond in North Andover:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat largemouth bass from this waterbody."
2. "The general public should limit consumption of largemouth bass to two meals per month."

Lake Attitash (Kimballs Pond) in Amesbury/Merrimac and Crystal Lake (Creek Pond) in Haverhill:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody."
2. "The general public should not consume any largemouth bass from this waterbody."
3. "The general public should limit consumption of non-affected fish from this waterbody to two meals per month."

Flint Pond in Tyngsborough:

1. "Children under 12, pregnant women and nursing mothers should not consume any fish from Flint Pond."
2. "The general public should not consume largemouth bass from Flint Pond."
3. "The general public should limit consumption of non-affected fish from Flint Pond to two meals per month."

Millvale Reservoir in Haverhill:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody."
2. "The general public should not consume any largemouth bass from this waterbody."

Hoveys Pond in Boxford, Long Pond (Lake Passaconaway) in Dracut/Tyngsborough and Massapoag Pond in Dunstable/Groton/Tyngsborough:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat any fish from this waterbody."
2. "The general public should limit consumption of all fish from this waterbody to two meals per month."

Merrimack River - all towns between Tyngsborough and Methuen:

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat white sucker or largemouth bass from this waterbody."
2. "The general public should limit consumption of white sucker and largemouth bass to two meals per month."

OBJECTIVES

This report summarizes information generated in the Merrimack River Basin through *Year 1* (information gathering in 1998) and *Year 2* (environmental monitoring in 1999) activities established in the "Five-Year Cycle" of the Massssachusetts Watershed Initiative. Data collected by the DEP Division of Watershed Management (DWM) in 1999, in accordance with their Quality Assurance Project Plans (MA DEP 1999b, MA DEP 1999c, and MA DEP 1999d), are provided in Appendices A, B, and C (QA/QC, water quality data, and one technical memorandum entitled *Merrimack River Watershed 1999 Biological Assessment*). Together with other sources of information (identified in each segment assessment), the status of water quality conditions of rivers, lakes and estuaries in the Merrimack River Basin was assessed in accordance with EPA's and DEP's use assessment methods. Not all waters in the Merrimack River Basin, however, are included in the WBS database or this report.

The objectives of this water quality assessment report are to:

1. evaluate whether or not surface waters in the Merrimack River Basin, defined as segments in the WBS database, currently support their designated uses (i.e., meet surface water quality standards),
2. identify water withdrawals (habitat quality/water quantity) and/or major point (wastewater discharges) and nonpoint (land-use practices, storm water discharges, etc.) sources of pollution that may impair water quality conditions,
3. identify the presence or absence of any non-native macrophytes in lakes,
4. identify waters (or segments) of concern that require additional data to fully assess water quality conditions and designated uses,
5. recommend additional monitoring needs and/or remediation actions in order to better determine the level of impairment and/or to improve/restore water quality, and
6. provide information to the Merrimack River Watershed Team for use in its annual and 5-year watershed action plans.

SOURCES OF INFORMATION

Multiple local, private, state and federal agencies provided information used in the water quality assessment of the Merrimack River Basin. Within DEP information was obtained from three programmatic bureaus: Bureau of Resource Protection (BRP, see below), Bureau of Waste Prevention (industrial wastewater discharge information) and the Bureau of Waste Site Cleanup (hazardous waste site cleanup information). Specifically, water quality, habitat assessment, biological and lake data were provided by DEP DWM's Watershed Planning Program. Water withdrawal and wastewater discharge permit information was provided by members of the Merrimack River Watershed Team in the DEP Central and Northeast Regional Offices and the DWM Watershed Permitting Program.

The mainstem Merrimack River and several of its tributaries receive the discharge of treated municipal and industrial wastewater, contact and non-contact cooling water (Appendix D, Tables D1 and D2). The following types of National Pollutant Discharge Elimination System (NPDES) discharges occur in the Merrimack River Basin (Hogan 2001):

- *Municipal wastewater treatment plants (WWTPs):* The watershed has six municipal WWTPs that discharge to the mainstem Merrimack River and one that discharges to a tidal creek. These facilities treat wastewater from domestic and industrial sources within the WWTP service area and range in size from the Greater Lawrence Regional Facility with a treatment capacity of 52 MGD to the Town of Merrimac wastewater treatment facility (WWTF) that has a capacity of 0.45 MGD and treats only municipal, sanitary wastewater. All facilities (with the exception of the Salisbury facility) have secondary treatment limits. The Salisbury WWTP has advanced limits with very restrictive effluent conditions since it discharges to a tidal creek (limited available dilution) and shellfish areas.

- *Combined Sewer Overflows (Brander 2001):* There are three Massachusetts CSO permittees in the Merrimack Basin: the cities of Lowell and Haverhill and the Greater Lawrence Sanitary District. There are also two upstream New Hampshire CSO permittees (Nashua and Manchester). All the MA CSO permittees are implementing "Nine Minimum Controls" programs to mitigate the frequency, duration, and impacts of their CSO discharges. All of these permittees are also in the midst of developing long-term control plans (LTCP) to address their CSO discharges and comply with the CWA and state and federal CSO policies. Early phases of the planning efforts have been completed to establish "baseline" conditions in these communities. The baseline reports for these permittees present the following estimates for present CSO discharges during a year of typical precipitation:

Permittee	# of CSO outfalls	# events/year	annual volume
Lowell	9	up to 37	352 MG
GLSD	5	up to 14	111 MG
Haverhill	20	up to 41	68 MG

These CSO discharges presently violate the Merrimack River Class B standard, as no CSO discharges are allowed to Class B receiving waters.

MA DEP and EPA will review each draft LTCP for compliance with applicable laws and regulations. These plans will also undergo the public environmental review process in accordance with the Massachusetts Environmental Policy Act. Early phases of the recommended plans are expected to address those CSOs with the greatest volume and impacts. Since the CSO planning process is not yet complete, it is unclear which CSO abatement technologies (e.g. storage vs. sewer separation vs. treatment) will be utilized or what will be the final level of control or associate water quality standard. A CSO-impacted segment can only be reclassified to B(CSO) or B(partial) or C if the findings of the CSO planning efforts identify levels of CSO control reflective of those classifications to be the highest feasible level of control.

There is also another noteworthy endeavor in the Merrimack basin being initiated by the CSO communities and the Merrimack River Watershed Council (MRWC) (Brander 2001 and Goodno 2001). The objective is to develop a comprehensive plan for improving water quality in the Merrimack River and selected tributaries. The United States Army Corps of Engineers (ACOE) has developed a scope for this multi-state water resources assessment study in concert with the communities and MRWC (ACOE 2001). The first phase of the study is estimated to cost about $2 million. The ACOE has been provided with federal appropriations of $500,000 and is likely to obtain additional federal funding as warranted for study completion. The federal funds must be matched with 50 percent by a non-federal sponsor in order for the study to start. The local communities Lowell, Lawrence, Haverhill Massachusetts and Nashua and Manchester, New Hampshire have joined together and formed an inter-municipal partnership called the "CSO coalition" to raise the required match from local funds and in-kind services. It is expected that the study will be initiated in January 2002 and be performed by the ACOE using consultant services. The study is intended to provide additional information on the sources of pollution within the basin; the range of water quality issues, ecosystem problems and opportunities along sections of the Merrimack River; to inform the communities and regulatory agency decisions on strategies to manage discharges in the watershed; and to integrate CSO and stormwater pollution abatement projects in the most cost-effective manner.

- *Industrial WWTPs and non-process discharges:*
  The majority of industrial process wastewaters are treated at municipal WWTPs under conditions of their industrial pre-treatment program. This program is controlled by the municipality and is a condition of the municipal WWTP NPDES permit. There are several industries that have permits for the discharge of non-contact cooling water and storm water. These discharges are authorized and controlled under general permits issued to the facilities by EPA. The associated impacts from these facilities are minimal and do not get significant environmental review from MA DEP.

Phase II NPDES storm water permits will be general permits. There are 15 "Phase II" communities in the Merrimack River Basin that include Amesbury, Andover, Chelmsford, Dracut, Groveland, Haverhill, Lawrence, Littleton, Lowell, Merrimac, Methuen, North Andover, Tewksbury, Tyngsborough, and Westford. EPA is currently writing this general permit (with input from DEP). The final version of the Phase II storm water permit will be issued in December 2002. Permit applications from the towns must be submitted to EPA by March 2003 and coverage begins with the permit application (Scarlet 2001).

<u>NPDES Toxicity Testing Discharge Monitoring Reports (DMRs):</u>
Seven municipal wastewater treatment plants and four industrial dischargers in the Merrimack River Basin submit toxicity testing reports to EPA and DEP as required by their NPDES permits. Data from these toxicity reports are maintained by DWM in a database entitled "Toxicity Testing Data - TOXTD". Information from the reports includes: survival of test organisms exposed to ambient river water (used as dilution water), physicochemical analysis (e.g., hardness, alkalinity, pH, total suspended solids) of the dilution water, and the whole effluent toxicity test results. Data from February 1996 to April 2001 were reviewed and summarized (ranges) for use in the assessment of current water quality conditions in the Merrimack River Basin.

- Amesbury WWTP MA0101754
- Gould, Inc., Newburyport MA0000281
- Greater Lawrence Sanitary District MA0100447
- Haverhill WPCF MA0101621
- Lowell WWTF MA0100633
- Lucent Technologies MA0001261
- Merrimac WWTF MA0101150
- Newburyport WPCF MA0101427
- Salisbury WWTP MA0102873
- Veryfine MA0004936
- Westford Anodizing MA0024414

A list of registered and permitted Water Management Act (WMA) withdrawals (both public water suppliers and other industrial users) is provided in Appendix D, Table D3 (LeVangie 2001). The following facilities also applied for a Nonconsumptive Use Status:

- Boott Hydropower (Accepted January 1989)
- Foundry Technology (rejected too small)
- Lawrence Hydroelectric Assoc. (Accepted January 1989)
- Massachusetts Hyro Assoc. (Accepted January 1989)
- Merrimack Paper (Accepted January 1989)
- North Canal Waterworks (Accepted January 1989)
- Proprietors of Locks & Canals (Issued July 1995)

Federal Energy Regulatory Commission (FERC) licensed hydroelectric power plants in the Merrimack River Basin in Massachusetts include the following:

Project Name	Project Number	Owner Name	River/Location	Kilowatts
Lowell	2790	Boott Hydropower, Inc.	Pawtucket Dam	24823
Lawrence	2800	Lawrence Hydro Assoc.	Merrimack River	16800
Aquamac	2927	Aquamac Corp.	South Canal (Merrimack River)	250
Merrimack	2928	Merrimack Paper Co, Inc.	South Canal (Merrimack River)	1088
Methuen Falls	8093	Methuen Falls Hydro Elec. Co.	Spicket River	357
Appleton Trust	9300	James T. Lichoulas	Hamilton Canal near Pawtucket Dam (Merrimack River)	346

Other state agencies contributing information to this report include: the Massachusetts Department of Public Health (MDPH), the Department of Fisheries, Wildlife, and Environmental Law Enforcement, Division of Fisheries and Wildlife, DMF and Riverways programs, and the Department of Environmental Management (DEM). Federal agencies contributing information to this report include the EPA, USGS and the ACOE.

In addition to state and federal agencies, regional, local and citizen monitoring groups provided valuable data/information, which may be used to indicate areas of degraded water quality, as well as causes and sources of contamination.

The Merrimack River Watershed Council (MRWC) is a 23-year old nonprofit membership organization whose mission is to..."*protect and restore the Merrimack River Watershed for the enjoyment of people, the benefit of its communities, and the health of the ecosystem*". MRWC has a growing constituency of individuals, businesses, municipalities and community groups seeking to protect the natural resources of the watershed. Working in partnership with these diverse interests, MRWC acts as a catalyst to improve the watershed environment through its advocacy center, and research work (Goodno 2001).

MRWC works with citizens, organizations and agencies to adopt the "watershed approach" in making wise land and water use decisions, protecting and preserving drinking water, providing recreation opportunities, and watershed advocacy. One of MRWC's programs, developed through the Merrimack River Initiative, is the Merrimack Volunteer Environmental Monitoring Network (VEMN). The purpose of the VEMN is to coordinate a network of new and existing river, lake and watershed monitoring groups and to provide technical and organizational guidance to that network. This program is a service center that assists community groups in developing and carrying out volunteer monitoring programs in the Merrimack River Watershed. Services provided by the VEMN include training, assistance with writing study designs, quality control plans, arranging lab services, community organizing, and fund raising (Goodno 2001).

Supported by MRWC and the Riverways Program, shoreline surveys were conducted in 1999 in four tributaries (Salmon Brook in Dunstable/Groton, MA and Nashua, NH, Lawrence Brook in Tyngsborough, Bare Meadow Brook in Methuen, and Cobbler Brook in Merrimac) and in 2000 in the Upper and Lower Stony Brook Watershed. Action plans were completed for both Bare Meadow and Cobbler brooks.

An understanding of water supply and demand in the Merrimack River Basin is currently being studied by the Merrimack River Water Council (Saravanapavan 2001). A report on *Data and Literature on the Water Use of the Merrimack River Watershed* focusing on the reach of the Merrimack River from Manchester NH to Newburyport MA is available (MRWC). A second phase of the project, the water demand projection and analysis, is currently underway (Saravanapavan 2001).

Merrimack River anadromous fish restoration efforts started in 1969 when the fishery agencies of Massachusetts and New Hampshire, the Bureau of Sport Fisheries and Wildlife, and the Bureau of Commercial Fisheries (now the National Marine Fisheries Service) mutually agreed to support a fisheries program (USFWS 2001a). A Strategic Plan for the restoration of Atlantic salmon to the Merrimack River basin was prepared in 1978, and subsequently endorsed by the Policy Committee in 1979. The Strategic Plan is to be revisited, at a minimum, every five years. In 1980-1981 a Fish Passage Action Plan was developed and adopted in 1981. This document addresses fish passage requirements for salmon and shad throughout the entire basin. The Strategic Plan was revised in 1982 in order to incorporate the Fish Passage Action Plan (USFWS 2001b). The Strategic Plan has set forth three goals to accomplish its mission of restoring and enhancing Atlantic salmon populations in the Merrimack River:

1. an adult Atlantic salmon population that will exceed the sea run brood stock holding capacity of the Nashua National Fish Hatchery (300) and provide some level of reproduction in the wild,

2. an annual average of 35,000 adult American shad passing the Essex fish-lift in Lawrence, and

3. an annual average of 300,000 adult river herring passing the Essex fish-lift in Lawrence.

Additionally, a stock enhancement aspect of the program involves the release of smolts and fry into the waters of the Merrimack and its tributaries (USFWS 2001c). As adult salmon return to the Merrimack River from the sea they are captured in the trapping facility associated with the fish-lift at the Essex Dam in Lawrence. Captured salmon are transported to an adult holding facility at the Nashua National Fish Hatchery in Nashua, NH until they mature sexually in the fall and eggs can be taken. The facility is capable of holding 300 adult salmon and any number greater than 300 would be transported to the spawning grounds within the headwaters (USFWS 2001c). At the present time, the salmon program requires six million eggs annually for the fry stocking program. At maximum capacity the sea run adult holding facility has the potential to produce approximately 25% of the projected need. In addition, approximately 4.5 million eggs are produced by hatchery brood stock. The fish are spawned and are then released for the interim brood stock sport fishery and for research purposes (USFWS 2001c).

In addition to releasing Atlantic salmon into the Merrimack River Basin, the restoration program provides upstream passage and salmon trapping capability at the lowermost impassible barrier dams. This includes the development of a fish lift concurrent with hydroelectric development at the Essex Dam in Lawrence, MA in the fall of 1982 and the construction of both a fish lift and fish ladder at the Pawtucket Dam in Lowell, MA in 1986 (USFWS 2001d). DMF and the Division of Fisheries and Wildlife count and trap fish at the Essex dam and the Pawtucket dam fish passage facilities (USFWS 2001a).

Progress made to date also reflects the partnerships that exist between the fisheries agencies, private industry (Consolidated Hydro, Inc. and Essex Hydro, etc.), and the private sector. Also, the Adopt-A-Salmon Family outreach program developed by the USFWS is directly related to anadromous fish restoration. This program uses the Atlantic salmon as a focus in order to facilitate the development of a watershed stewardship ethic among local communities. The program has lead to strong partnership development with organizations/agencies such as Consolidated Hydro, Inc. (USFWS 2001d).

The US Fish and Wildlife Service collected fish from the Merrimack River in the summer and fall of 1998 as part of their ecological risk assessment for wintering bald eagles and an EPA human health assessment for striped bass (Major 2001). Whole fish were sent to the EPA Region 1 Office of Environmental Measurement & Evaluation in Lexington, Massachusetts for subsequent processing and analysis. The whole fish samples were analyzed for mercury, lead and cadmium as well as chlorinated pesticides, total PCB, and percent lipids (McDonald 1999).

The USGS, as part of their National Water-Quality Assessment (NAWQA) Program in the New England Coastal Basins (Maine, Massachusetts, New Hampshire, and Rhode Island) study unit, conducted water quality sampling in the Merrimack River between 1998 and 2000 at their gaging station (01100000) at Lowell, MA. These data are published in the Water Resources Data Massachusetts and Rhode Island Water Year 1999 and 2000 reports (Socolow *et al.* 2000 and Socolow *et al.* 2001).

A New England Coastal Basin (NECB) Mercury Study was also initiated by USGS in 1999 when the results of their National Mercury Pilot Study showed some of the highest mercury concentrations in the country were in the NECB study area (USGS 13 June 2001). The dominant source of mercury identified in the NECB study area was atmospheric deposition. In collaboration with USGS's Toxics Substances Hydrology Program (an extension of the National Mercury Pilot Study), Urban Land Use Gradient Study (part of the NAWQA program) and the DEP Merrimack Valley Fish Study (described below), USGS collected, sediment, water, and/or fish tissue for total and/or methyl mercury analysis from 22 streams north of Boston in 1999 and 30 sites in the NECB in 2000. Both the Merrimack River at Lowell and Stony Brook in Chelmsford were sampled by USGS between June 1999 and August 2000. These data, however, are not yet available.

A directed study of fish in lakes in northeastern Massachusetts was performed by the DEP Office of Research and Standards (ORS) during 1999 in order to examine possible spatial patterns in the occurrence of higher fish mercury concentrations and to compare the fish contamination situation in this localized geographic region to statewide and regional data (MA DEP 2000b). Northeastern Massachusetts has an important history of industrialization dating back into the nineteenth century with the extensive burgeoning of mills along the Merrimack River. Most of this industry is now gone and the infrastructure for the mills is now slowly being converted to non-manufacturing uses. Many of the older, larger towns are relatively densely populated areas, yet surrounding lands are relatively undeveloped. This region was recently identified through the use of an air deposition model as having the highest predicted annual levels of recent wet and dry atmospheric deposition of mercury in the state. The area has the state's largest concentration of point sources of atmospheric mercury emissions: three municipal solid waste incinerators and a medical waste incinerator. Zones downwind from major point sources may be subject to increased deposition of a variety of contaminants. While historic records of atmospheric mercury deposition in this area do not exist, past widespread burning of coal for domestic heat and industrial boilers in the late nineteenth and first half of the twentieth centuries probably contributed to a relatively high background mercury signature in the environment of this part of the state. The objectives of the study were to:

1) sample fish from many lakes in northeastern MA where fishing takes place in order to determine if fish consumption advisories are needed for those lakes;

2) determine whether the frequency of advisories is greater in this area than across the state as a whole;

3) determine if there are any spatial patterns in fish mercury concentrations within the study area related to the locations of the major point sources of mercury emissions;

4) determine how well measured mercury concentrations match those predicted by a fish tissue mercury prediction model developed by MA DEP;

5) compare mercury concentrations in fish from the region with those from other parts of Massachusetts.

The lakes sampled in this study were chosen on the basis of the following: size of lake (4 hectares minimum size), availability of fish species, fishing pressure, access, and proximity to other lakes. Three lakes in the Merrimack River Basin selected for inclusion in this study were sampled by DWM in cooperation with ORS: Chadwicks Pond (Haverhill), Johnsons Pond (Groveland), and Cochichewick Lake (North Andover).

Fourteen other lakes and ponds selected for inclusion in this study in the Merrimack River Basin were sampled by Normandeau and Associates (under contract to DEP ORS) and/or the city of Haverhill:

- Lake Attitash (Amesbury, Merrimack)
- Crystal Lake (Haverhill)
- Forest Lake (Methuen)
- Haggetts Pond (Andover)
- Hoveys Pond (Boxford)
- Kenoza Lake (Haverhill)
- Long Pond (Dracut/Tyngsborough)
- Massapoag Pond (Dunstable/Groton/Tyngsborough)
- Millvale Reservoir (Haverhill)
- Newfield Pond (also known as Freeman Lake, Chelmsford)
- Lake Pentucket (Haverhill)
- Lake Saltonstall (Haverhill)
- Stevens Pond (Lawrence)
- Stevens Pond (North Andover)

The only pond sampled in the Merrimack River Basin as part of the study that does not have a site-specific advisory for mercury is Stevens Pond, Lawrence.

The National Shellfish Sanitation Program (NSSP) includes federal and states governments cooperatively administering a battery of public health regulations designed to assure the sanitary integrity of shellfish and shellfish products. A key regulatory role assigned to coastal states by the NSSP is shellfish classification. According to methods, procedures and standards set forth in the NSSP "Guide For The Control Of Molluscan Shellfish" (ISSC 2000) a designated state agency must determine whether shellfish from coastal growing waters are safe or may be made safe for human consumption. The determination is predicated, in large part, upon the presence of fecal coliform bacteria within the growing waters. Fecal coliform bacteria are an indicator of human and animal waste pollution, which represents the principle cause of shellfish transmitted illnesses via the feces to oral route.

The DMF Shellfish Management Program maintains information used to classify (e.g., approved, conditionally approved, prohibited) their shellfish management areas. These classifications are subsequently used to regulate the harvesting of various shellfish (Churchill 1999). DMF shellfish management areas also include acreage in the Merrimack River Basin not designated as segments in this report. Appendix E includes the complete listing of DMF shellfishing closures as of July 2000 in the Merrimack River Basin. Conservation of the shellfish resource, fisheries management and the protection of public health are goals of DMF's Shellfish Management Program.

DMF conducts fecal coliform bacteria sampling as part of their Sanitary Surveys by which a classification for the shellfish growing areas is assigned. These data are collected for the sole purpose of protecting public health. Shellfish species, habitat location, relative abundance and related fisheries must also be documented. A shoreline survey is conducted to identify pollution sources and evaluate potential impacts. Concomitantly, an understanding of hydrographic characteristics that may influence contaminant distribution and removal over the growing area is evaluated. Supplementary analysis may be required for naturally occurring pathogens (i.e., *Vibrio* spp.), marine biotoxins (i.e., Paralytic Shellfish Poisoning) or hazardous wastes in growing areas with a known history of contamination by these harmful substances.

Sanitary surveys are repeated at least every twelve years for growing areas classified other than Prohibited. Survey information is kept current through annual and triennial reports and classifications maintained with extensive monitoring. A growing area classification may be downgraded and management plans amended based on the findings of annual and triennial reviews. Classification upgrades can only be made based on the findings of a sanitary survey.

Site specific evaluations of other water quality issues in the Merrimack River Basin related to either wastewater discharges and/or water withdrawals were conducted either through field investigations (where resources could be allocated) or through the review of DMRs and annual water withdrawal reports submitted by the permittees.

The Lowell Regional Wastewater Utility conducted monthly water quality monitoring at five stations along the mainstem Merrimack River in 1999 and 2000 and from Black Brook, Beaver Brook, the Pawtucket Canal and two stations on the Concord River (Murphy 1999 and 2000). Unfortunately, the information provided did not meet minimum data acceptability criteria required by EPA and MA DEP for use in reporting 305(b) assessments.

Projects funded through various DEP grant and loan programs also provide valuable information that may be used in the water quality assessment report. A summary of these projects for the Merrimack River Basin is provided in Appendix F.

TOTAL MAXIMUM DAILY LOADS (TMDL)

As part of the Federal Clean Water Act, states are required to develop total maximum daily load (TMDLs) for lakes, rivers and coastal waters not meeting the states surface water quality standards as indicated by the states 303d list of impaired waters. A TMDL is the greatest amount of a pollutant that a waterbody can accept and still meet standards. Further information on the 303d list and the TMDL program are available on the DEP website at: http://www.dep.state.ma.us/dep/brp/wm/wmpubs.htm.

RIVERS

The ACOE has proposed a study of overall water quality conditions on the Merrimack River. Several cities and towns in New Hampshire and Massachusetts have indicated an interest in cooperating on this effort, which includes assessing impacts on water quality from combined sewer overflows (Brander 2001 and Goodno 2001). In addition to the municipalities, the MRWC and the Merrimack River Watershed Team have been active in proposing and pursuing support for this effort. The initial phase would include a special emphasis on bacteria and nutrients as well as on current and potential uses of the Merrimack River. The study requires cost-sharing with the federal government and the necessary match is being pursued.

LAKES

There are eleven lakes in the Merrimack River Basin on the 1998 303(d) list for which the most common cause of impairment is noxious aquatic plants (Table 3). A single draft TMDL for Total Phosphorus (a land-use based model) is being developed for seven of these lakes: **Flint Pond** (MA84012), Tyngsborough; **Long Pond** (84032), Dracut/Tyngsborough; **Mill Pond North** (MA84038), Littleton; **Newfield Pond** (MA84046), Chelmsford; **Mill Pond South** (MA84081), Littleton; **Massapoag Pond** (MA84087), Dunstable/Groton/Tyngsborough; **Ward Pond** (MA84096), Ashburnham (Mattson 2001). Baseline lake surveys were completed in 1999 by DWM for the purpose of this TMDL development in three of the seven lakes (Newfield, Massapoag and Flint ponds). Draft Total Phosphorus TMDLs will be available for public comment in 2001, with the final revised version scheduled to be submitted to EPA by the end of 2001 (Mattson 2001). TMDLs for the remaining Merrimack River Basin lakes are scheduled to be developed on the "Five-year watershed cycle" in 2006.

SEGMENT REPORT FORMAT

The segment order in this assessment report follows the Massachusetts Stream Classification Program hierarchy (Halliwell *et al.* 1982). Stream and estuarine segments are organized hydrologically (from most upstream to downstream) and tributary summaries follow the segment into which they discharge. Lake segments, ordered alphabetically, are presented after the stream and estuarine segments. Each segment summary is formatted as follows:

SEGMENT IDENTIFICATION

Name, water body identification number (WBID), location, length, classification.

Sources of information: coding system (waterbody identification number e.g., MA84A-01) used by DEP to reference the stream segment in databases such as 305(b) and 303(d), the Massachusetts SWQS (MA DEP 1996), and other descriptive information.

SEGMENT DESCRIPTION

Major land-use estimates (the top three uses for the subwatershed excluding "open water") and other descriptive information.

Sources of information: base geographic data from MassGIS, land use statistics from a GIS analysis using the MassGIS land use coverage developed at a scale of 1:25,000 and based on aerial photographs taken in 1990 and 1997 (UMass Amherst 1999):

SEGMENT LOCATOR MAP

Subbasin map, major river location, segment origin and termination points, and segment drainage area (gray shaded).

Sources of information: MassGIS data layers (stream segments and quadrangle maps) (MassGIS 2000).

WATER WITHDRAWAL AND WASTEWATER DISCHARGE PERMIT INFORMATION

Includes available water withdrawal and NPDES wastewater discharge information.

Sources of information: WMA Database Printout (LeVangie 2001); open permit files located in Wilmington and Worcester DEP Offices (MA DEP 2001b, Casella 2001, O'keefe 2001, Lemerise 2001, Hack 2001a).

USE ASSESSMENT

Aquatic Life, Fish Consumption, Drinking Water (where applicable – see note below), Primary Contact, Secondary Contact, and Aesthetics.

Sources of information include: DWM 1999 survey data (Appendix B and C); DEP DWM Toxicity Testing Database "TOXTD"; DMF Shellfish Management Program data (Kennedy 2001), USGS water quality and streamflow data (Socolow *et al.* 2000, Socolow *et al.* 2001, USGS 13 June 2001) and EPA/USFWS fish contaminant concentration data (McDonald 1999, Major and Carr 1991); the MA DPH Freshwater Fish Consumption Advisory List (MDPH 2001a) was used to determine the *Fish Consumption Use* and the DMF Shellfish Status Report (DFWELE 2000) was used to assess the *Shellfishing Use* . Where other sources of information were used to assess designated uses, citations are included.

[Note: Although the *Drinking Water Use* itself was not assessed in this water quality assessment report, the Class A waters were identified.]

SUMMARY

Use summary table (uses, status, causes and sources of impairment).

RECOMMENDATIONS

Additional monitoring and implementation needs.

MERRIMACK RIVER BASIN– RIVER AND ESTUARY SEGMENT ASSESSMENTS

There are a total of 25 river segments and five estuarine segments include in this report (Figure 8). Reporting for Plum Island River and Plum Island Sound has been changed from the Merrimack River Basin to the Parker River Basin/ Plum Island Sound Coastal Drainage Area with new waterbody identification codes (WBIDs) – MA91-15 and MA91-12, respectively. Current information on water quality conditions for these segments can be found in the Parker River Watershed Water Quality Assessment Report (Weinstein and Connors 2001).

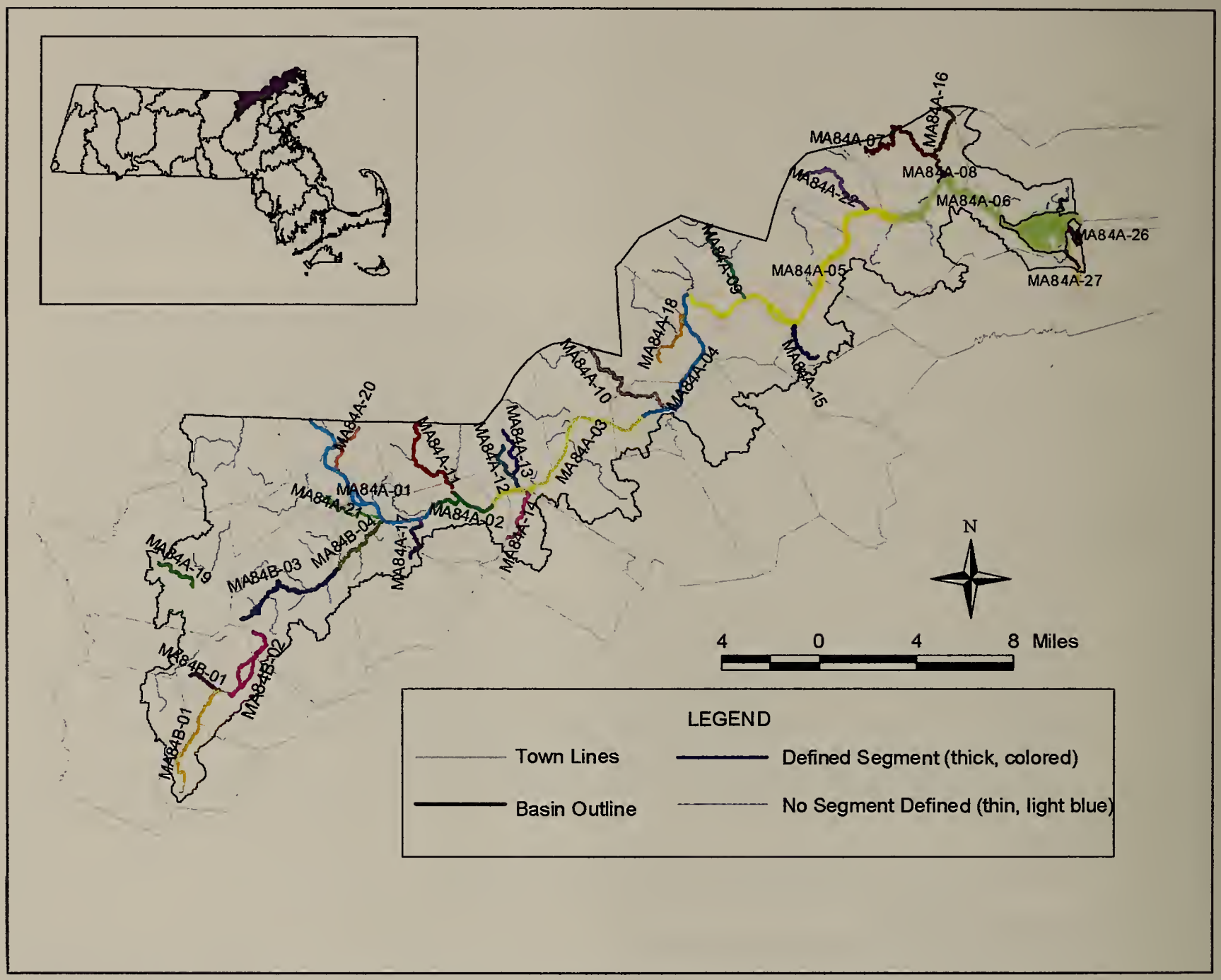
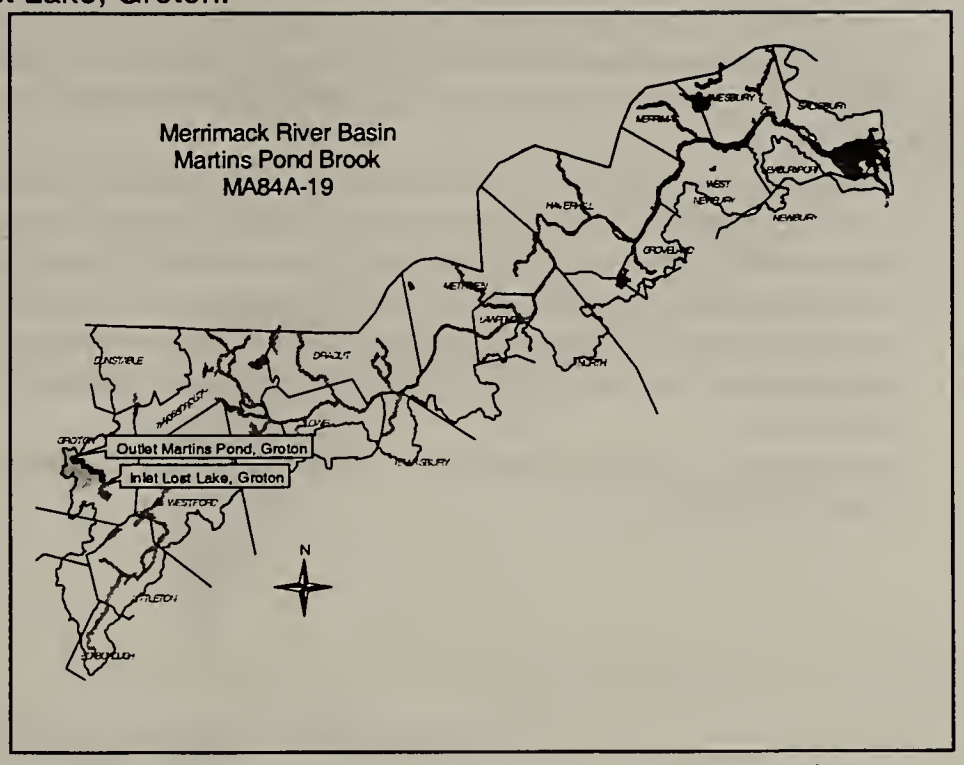


Figure 8. Merrimack River Basin – River and Estuary Segment Locations identified by WBID.

MARTINS POND BROOK (SEGMENT MA84A-19)

Location: Outlet Martins Pond to inlet Lost Lake, Groton.
Size: 2.4 miles.
Classification: Class B.

Martins Pond Brook is a headwater stream in the Salmon Brook subwatershed of the Merrimack River Basin. Salmon Brook discharges to the mainstem Merrimack River in Nashua, NH (Rapp 1999a).



Land-use estimates (top three) for the Martins Pond Brook subwatershed (map inset, gray shaded area):

Forest	44%
Residential	19%
Agriculture	17%

This segment is on the 1998 303(d) list of impaired waters, needing confirmation, for siltation, organic enrichment/low dissolved oxygen (DO), and turbidity (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Groton Water Department	2115000	9P21311501	21311501	Shattuck Well 115-01G Baddacook Well	0.22reg* 0.33per* 0.55total*	0.50*

* indicates system-wide withdrawal; all sources are not necessarily within this segment

NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated surface wastewater discharges in this segment.

USE ASSESSMENT SUMMARY:

Too little current data are available to assess the designated uses of Martins Pond Brook. The brook was last surveyed by DWM (benthic macroinvertebrate rapid bioassessment protocol (RBP) II evaluation indicated moderate impairment) in August 1990 (Smith *et al.* 1990). Habitat quality degradation (erosion and sedimentation) was observed at that time. A shoreline survey of Martins Pond Brook was carried out by the MRWC and the Groton Lakes Association in August/September 1999. The narrative of their report stated that the reach of Martins Pond Brook to the Route 40 culvert was dry until two days prior to their survey (Rapp 1999a). They did not identify any other issues of concern.

Martins Pond Brook (MA84A-19) Use Summary Table

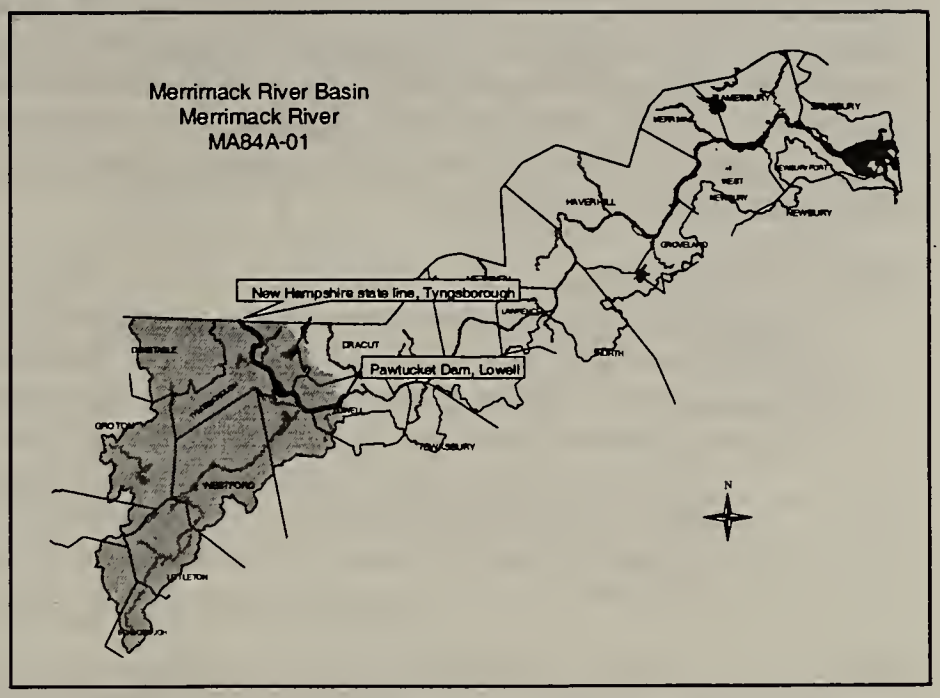
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: MARTINS POND BROOK (SEGMENT MA84A-19)

- As part of the WMA 5-year review process, DEP should continue to evaluate Groton Water Department's compliance with WMA registration and/or permit limits.
- A habitat assessment should be conducted for Martins Pond Brook. It should encompass habitat quality as related to streamflow as well as identify areas, if any, of sediment deposition caused by erosion.
- Consideration should be given to conducting benthic macroinvertebrate and fish population surveys.
- Evaluate the flow management practices (e.g., outlet control operations) of the Martins Pond as they may relate to the observed "dry"/low-flow conditions in the brook.
- Collect additional data to determine the frequency, duration, and spatial extent of the low flow conditions and DO concentrations in the Martins Pond Brook. If attempts are made to optimize streamflow in the brook, document any changes to ambient water quality (e.g., DO, temperature) in the brook.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

MERRIMACK RIVER (SEGMENT MA84A-01)

Location: State line at Hudson, NH/Tyngsborough, MA to Pawtucket Dam, Lowell.
Size: 9.2 miles.
Classification: Class B, Warm Water Fishery, Treated Water Supply.



Land-use estimates (top three) for the Massachusetts portion of this subwatershed less the South Branch Souhegan River area (map inset, gray shaded area):

Forest	47%
Residential	27%
Open Land	7%

This segment is on the 1998 303(d) list of impaired waters for pathogens (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Dracut Water District	3079000	9P231307901	31307902	Tynsboro (also known as Frost Road) Wellfield: 04G 05G 06G 07G 08G	0.79 reg* 1.37 per* 2.16 total*	Unavailable (Data considered unreliable)
Vesper Country Club			21330101	Well #1 Well #2 Well #3 River Intake	0.23	0.10
Lowell Water Treatment Facility	3160000	9P231316003	31316001	Merrimack River Intake	13.84 reg 5.18 per 19.02 total	14.04

* indicates system-wide withdrawal; all sources are not necessarily within this segment

NPDES WASTEWATER DISCHARGE SUMMARY:

The Pheasant Lane Mall, Tyngsborough (MA0030597) discharge is tied into the Nashua WWTP. The Vulkor Inc., Lowell facility (MA0003883) closed down and no longer discharges contact and non-contact cooling water.

It should be noted that Tyngsborough, Chelmsford, Lowell and Dracut are Phase II Stormwater communities. These communities must apply for permit coverage for their municipal drainage systems and are required to develop, implement and enforce their storm water management programs by March 2003 (Domizio 2001).

USE ASSESSMENT:

AQUATIC LIFE

Chemistry – tissue

The USFWS conducted a screening-level survey to determine the state of contamination of selected priority pollutants (e.g., PCB, lead, mercury, cadmium, copper, etc.) in whole fish samples collected from the mainstem Merrimack River in 1982 and 1985 (Major and Carr 1991). The study found that PCB concentrations in whole fish samples from the mainstem Merrimack River in both New Hampshire and Massachusetts ranged from 0.09 to 4.1 ppm wet weight.

This segment of the Merrimack River is affected by multiple upstream discharges (NPDES permittees, power plants, and CSOs). Because of these threats to aquatic life, it is best professional judgment that there are insufficient data to characterize the status of the *Aquatic Life Use* and, therefore, it is not assessed. Because of the elevated concentration of PCB documented in whole fish collected in the Merrimack River in 1982 and 1985 (Major and Carr 1991) and from downstream reaches of the river in 1998 (McDonald 1999), it is best professional judgment that the *Aquatic Life Use* for this segment be identified with an "Alert Status".

FISH CONSUMPTION

In September 1994 fish toxics monitoring was conducted by DWM in this segment of the Merrimack River. These data can be found in Appendix B, Table B8. Based on these data, the DPH issued a fish consumption advisory due to mercury contamination for the Merrimack River - all towns between Tyngsborough and Methuen, as follows (MDPH 2001a):

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat white sucker or largemouth bass from this waterbody."
2. "The general public should limit consumption of white sucker and largemouth bass to two meals per month."

Because of the site-specific MDPH fish consumption advisory, which encompasses this segment of the Merrimack River, the *Fish Consumption Use* is assessed as non-support due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

PRIMARY* AND *SECONDARY CONTACT RECREATION

Fecal coliform bacteria samples were collected at the Lowell Water Treatment Plant Merrimack River Intake by DEP as part of their Microbial Indicator Study of the Merrimack River (Appendix G). Of the four samples collected between August 1999 and April 2001, none exceeded 150 cfu/100 mls (Appendix G, Table G1). Fecal coliform bacteria samples were collected at the boat ramp along the Merrimack River by DEM in the Lowell Heritage State Park (upstream of the park swimming area) (Scott 1999). Unfortunately, the information provided did not meet minimum data acceptability criteria. The swimming area at the Lowell State Park is, however, frequently closed during the summer because of elevated fecal coliform bacteria counts (Scott 2001).

Since the public beach at the Lowell Heritage State Park has been frequently closed to swimming as a result of elevated bacteria counts, the *Primary Contact Recreational Use* is assessed as non-support for the lower 1.4-mile reach of this segment. The status of the *Primary Contact* R*ecreational Use* in the upper 7.8-mile reach and the *Secondary Contact Recreational Use* for the entire length of this segment are not assessed because of too little quality-assured data. These uses are, however, identified with an "Alert Status" because of the presence of CSO discharges in Nashua, NH and other upstream communities as well as urban runoff. Waterfowl populations at the Lowell Heritage State Park beach are also a likely source of elevated bacteria counts in the lower 1.4-mile reach (Blumeris 2001a).

AESTHETICS

The Merrimack River Watershed Council reports that this segment of the Merrimack River is enjoyed by canoeists and is generally aesthetically pleasing (Goodno 2001). The upper reach of this segment is, however, subject to erosion and is turbid after rain events. The Vesper Country Club has also reported that Tyngs Island is eroding (Goodno 2001).

The *Aesthetics Use* is assessed as support, however, it is identified with an "Alert Status" due to reports of erosion problems and turbidity.

Merrimack River (MA84A-01) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life*		NOT ASSESSED				
Fish Consumption		NON SUPPORT	Mercury		Unknown	Atmospheric Deposition
Primary Contact*		NOT ASSESSED upper 7.8 miles NON SUPPORT lower 1.4 miles	Pathogens		CSO, urban runoff/storm sewers	Dense waterfowl populations
Secondary Contact*		NOT ASSESSED				
Aesthetics*		SUPPORT				

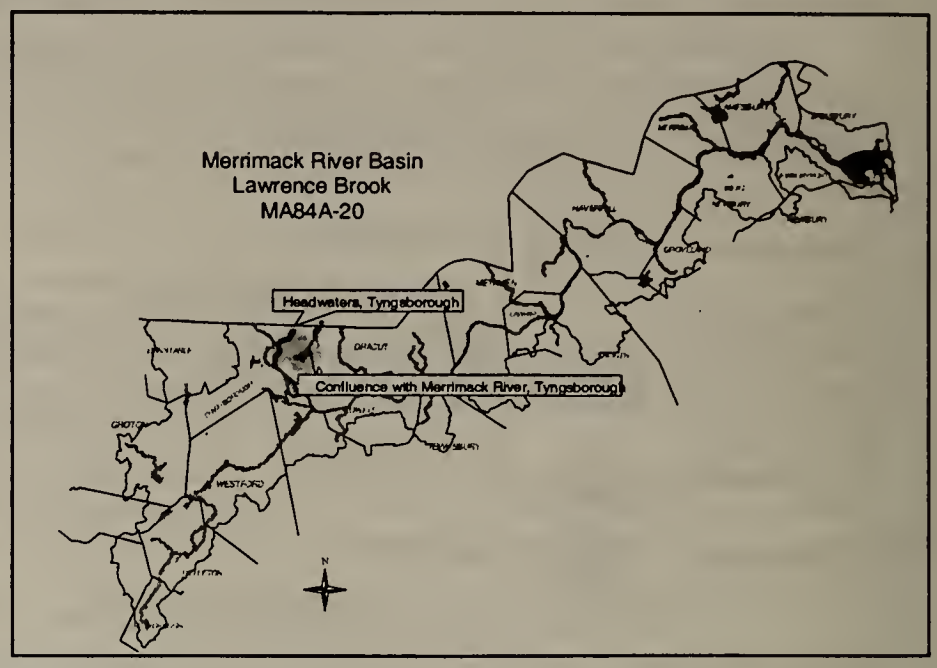
* "alert status" issues identified, details in this segment's USE ASSESSMENT section

RECOMMENDATIONS: MERRIMACK RIVER (SEGMENT MA84A-01)

- Additional information should be collected in the upper reaches of this segment of the Merrimack River to determine the frequency and extent of erosion (Tyngs Island) and instream turbidity after rain events.
- Conduct additional monitoring (e.g., passive water column PCB samplers, whole fish tissue), to determine the extent, and if necessary, source(s) of PCB contamination.
- Determine locations of current and historical sources of PCB in the Merrimack River and in its tributaries.
- Conduct biological monitoring (e.g., benthic macroinvertebrates, fish population) to evaluate the effect(s), if any, of the multiple upstream discharges (NPDES permittees, power plants, and CSOs) on aquatic life in this segment of the Merrimack River.
- Collect water quality data, including bacteria data, to evaluate the effectiveness of CSO abatement projects being implemented in New Hampshire CSO communities.
- Continue to review water quality data (including any data from the ACOE project) to identify hotspots and integrate CSO and stormwater management activities to maximize water quality benefits.
- Implement methods to discourage/reduce the waterfowl population at the Lowell Heritage State Park.
- As part of the WMA 5-year review process, DEP should continue to evaluate Dracut Water District, Vesper Country Club and Lowell Water Treatment Facility compliance with WMA registration and/or permit limits.

LAWRENCE BROOK (SEGMENT MA84A-20)

Location: Headwaters to confluence with Merrimack River, Tyngsborough.
Size: 2.35 miles.
Classification: Class B.



Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Residential	40%
Forest	37%
Agriculture	4%

This segment is on the 1998 303(d) list of impaired waters, needing confirmation, for unknown toxicity (Table 3).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information there are no WMA regulated water withdrawals or surface wastewater discharges in this subwatershed. It should be noted however that Tyngsborough is a Phase II Storm Water community. Tyngsborough must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:

Too little current data are available to assess the designated uses of Lawrence Brook. The brook was last surveyed by DWM (benthic macroinvertebrate RBP II evaluation indicated moderate impairment) in August 1990 (Smith *et al.* 1990). Habitat quality was excellent. A shoreline survey of Lawrence Brook was carried out by the Lawrence Brook Stream Team Volunteers in May 1999. No major problems were identified, however, there were a few isolated areas of trash/debris (Rapp 1999b). The narrative of their report stated a condominium complex along the lower reach of the Lawrence Brook was identified as having septic system failures (Rapp 1999b). There have not been any complaints to the DEP Northeast Regional Office (NERO) regarding odor or aesthetic problems however (Casella 2001).

Lawrence Brook (MA84A-20) Use Summary Table

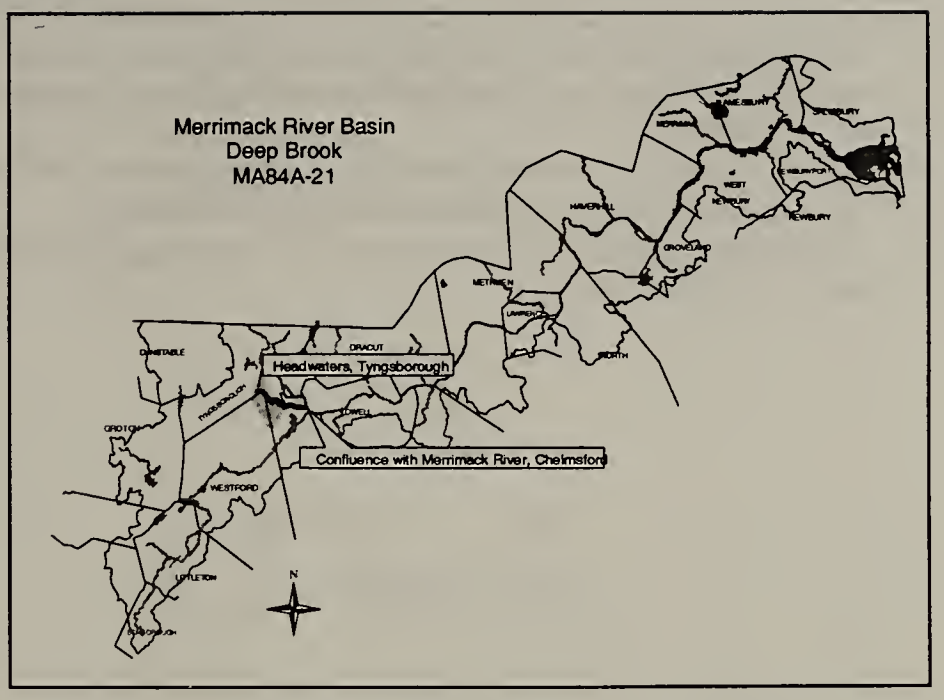
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: LAWRENCE BROOK (SEGMENT MA84A-20)

- A site inspection at the condominium complex to evaluate possible septic system failure should be conducted. Bacteria monitoring in Lawrence Brook bracketing the complex should also be conducted.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

DEEP BROOK (SEGMENT MA84A-21)

Location: Headwaters, East of Everett Turnpike, Tyngsborough to confluence with Merrimack River, Chelmsford.
Size: 3.05 miles.
Classification: Class B.



Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	52%
Residential	23%
Transport	7%

This segment is on the 1998 303(d) list of impaired waters, needing confirmation, for pathogens, organic enrichment/low DO, siltation and unknown toxicity (Table 3). It should be noted that Chelmsford has received State Revolving Fund (SRF) funding to implement their Long Term plan to eliminate Title V systems and install sewers in the community (Barber 2001a).

WMA WATER WITHDRAWAL SUMMARY:
Based on the available information there are no WMA water withdrawals in this subwatershed.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D2):
Browning-Ferris Industries, Inc. in Tyngsborough (MA0030066) is authorized to discharge (permit issued September 1997) treated storm water runoff from their refuse hauling truck refueling, cleaning and storage area via six outfalls (# 001, 002, 003, 004, 006, and 007) to Deep Brook and "Bridge Meadows".

Texaco Station in North Chelmsford recovery system discharge (MA0035092) has been terminated (Neas 2001).

It should also be noted that both Chelmsford and Tyngsborough are Phase II Storm Water communities. These communities must apply for permit coverage for their municipal drainage systems and are required to develop, implement and enforce their storm water management programs by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:
Too little current data are available to assess the designated uses of Deep Brook. The brook was last surveyed by DWM (benthic macroinvertebrate RBP II evaluation indicated moderate impairment at the station sampled downstream of Ledge Road in Chelmsford) in August 1990 (Smith *et al.*1990). Although habitat quality was somewhat degraded (large amounts of sand, mud and organic matter) wild brook trout were observed.

Deep Brook (MA84A-21) Use Summary Table

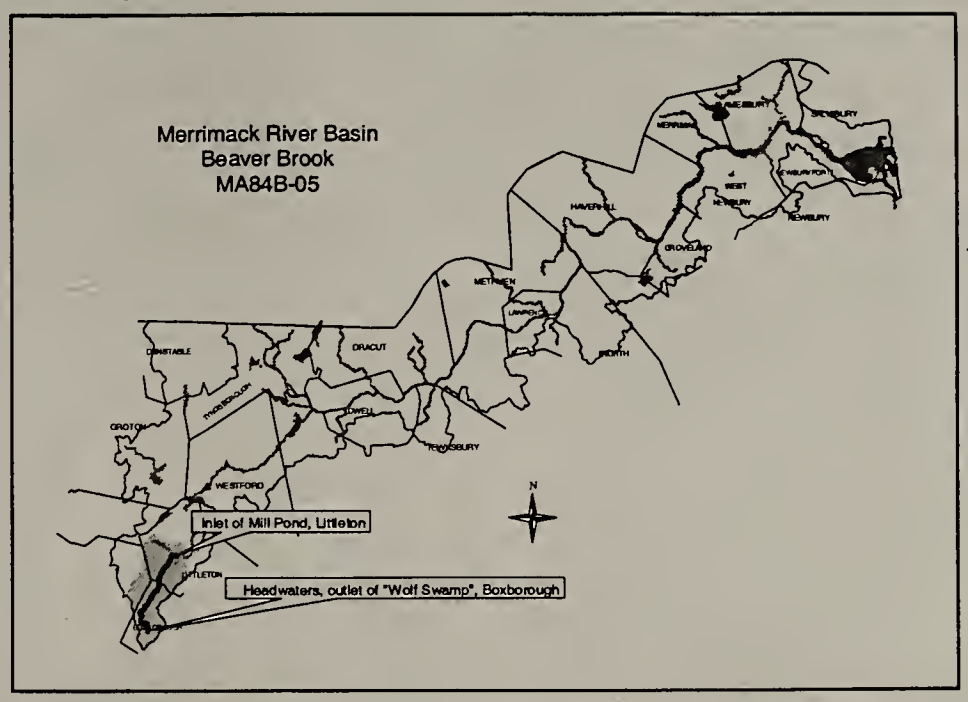
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: DEEP BROOK (SEGMENT MA84A-21)

- Evaluate Browning-Ferris Industries, Inc. compliance with their storm water pollution prevention plan.
- Conduct benthic macroinvertebrate and fish population surveys to document any changes in water quality conditions as a result of infrastructure improvements (e.g., installation of sewers, stormwater management).
- Conduct instream bacteria sampling to evaluate the effectiveness of Chelmsford's actions to eliminate Title V systems and install sewers in the community.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

BEAVER BROOK (SEGMENT MA84B-05)

Location: Headwaters, outlet of "Wolf Swamp", Boxborough to inlet of Mill Pond, Littleton.
Size: 5.4 miles
Classification: Class B.



Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	53%
Residential	14%
Agriculture	10%

Cisco Development Partners-NEDC, LLC has purchased property along the upper portion of Beaver Brook (Carney 2000). They have a WMA permit (0.14 MGD).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Cisco Development Partners-NEDC, LLC		9P221303701		BW#1 BW#2 BW#3 BW#4 BW#5 BW#6	0.14	Not on-line
Littleton Water Department	2158000	9P21315802	21315803	01G 02G	0.84reg* 0.63per* 1.47total*	1.14*

* indicates system-wide withdrawal; all sources are not necessarily within this segment/subwatershed

NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated surface wastewater discharges in this segment. It should be noted however that Littleton is a Phase II Storm Water community. Littleton must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:

Too little current data are available to assess the designated uses of Beaver Brook. A shoreline survey of portions of this segment of Beaver Brook was carried out by the MRWC and the Upper Stony Brook Stream Team in May 2000. The team noted isolated areas of road runoff resulting in some bank erosion littered with trash/debris (Carney 2000). A hydrological assessment of the Stony Brook subwatershed has been funded through the MWI but to date the project has not been started (Appendix F).

Beaver Brook (MA84B-05) Use Summary Table

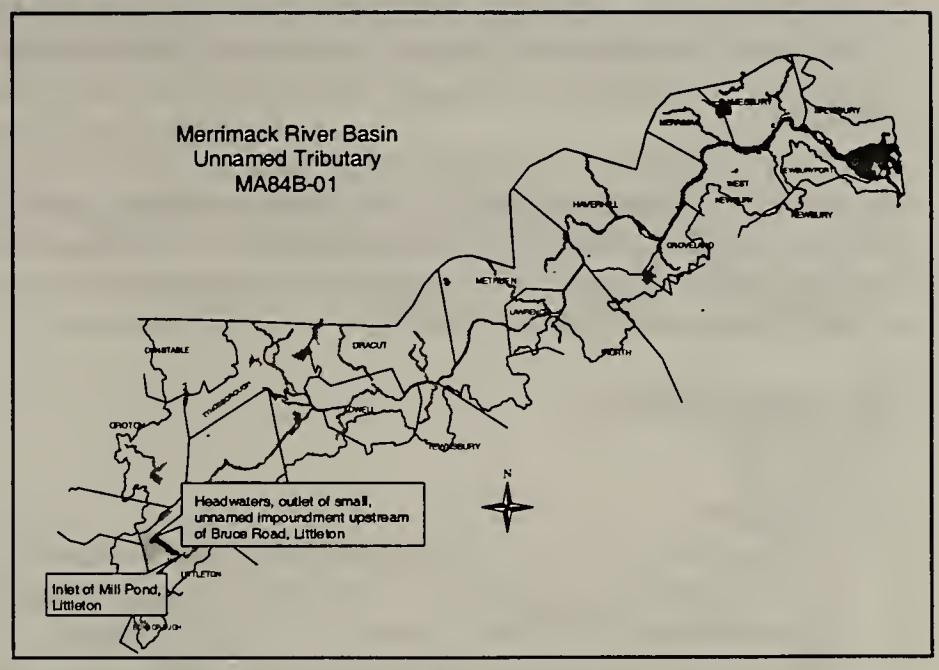
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: BEAVER BROOK (SEGMENT MA84B-05)

- Review the Cisco Development Partners-NEDC, LLC development plan for their property along Beaver Brook. Best mangement practices (BMPs) to control construction related runoff and minimize any adverse impacts to the brook should be required.
- Continue to evaluate Littleton Water Department's compliance with WMA registration and/or permit limits.
- A habitat assessment should be conducted for Beaver Brook. It should encompass habitat quality as related to streamflow as well as identify areas, if any, of sedimentation and erosion.
- When complete review the results of the hydrological assessment of the Stony Brook subwatershed project to determine future data needs and other action items.

UNNAMED TRIBUTARY "REEDY MEADOW BROOK" (SEGMENT MA84B-01)

Location: Headwaters, outlet of small unnamed impoundment west/upstream of Bruce Road, Littleton to inlet of Mill Pond, Littleton (locally known as "Reedy Meadow Brook").
Size: 1.5 miles
Classification: Class B.



Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	53%
Residential	15%
Agriculture	12%

This unnamed tributary is locally known as "Reedy Meadow Brook". It is on the 1998 303(d) list of impaired waters (the origin was incorrectly described as Unnamed Tributary, headwaters, outlet of "Wolf Swamp", Boxborough) for pH, organic enrichment/low DO, suspended solids, pathogens and nutrients (Table 3). It is a tributary to Mill Pond, a hypereutrophic waterbody.

A hydrological assessment of the Stony Brook subwatershed has been funded through the MWI but to date the project has not been started (Appendix F).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Aggregate Materials Corporation			21315802	Settling Pond Aggregate Well 6 – LoneStar/San Vel Well 5 – LoneStar/San Vel Well 4 – LoneStar/San Vel Settling Pond Crusher Well 7 – LoneStar/San Vel Well 3 – LoneStar/San Vel	1.58	0.90
Veryfine, Inc.		9P21315801	21315801	Process Well #1 Process Well #2	0.22reg 0.22per 0.44total	0.18

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D2):

Veryfine Products, Inc. is permitted (MA0004936) to discharge (permit issued March 2000) via outfall #001, 0.75 MGD of treated effluent to "Reedy Meadow Brook". Additional water is from the town supply. The facility's whole effluent toxicity limits (permit requires testing with *Pimephalas promelas*) are lethal concentration to 50% of the test organisms (LC_{50}) $\geq$ 100% and the chronic no observed effect concentration (CNOEC) $\geq$ 91% effluent. The pH of the facility's discharge, ranging from 7.4 to 8.6 SU, was within their permit limit (6.5 to 9.0 SU). The effluent must also meet a total phosphorus limit (expressed as pounds/day). Veryfine Products, Inc. is also authorized to discharge storm water from Lagoon No. 1 via outfall #002 to Reedy Meadow Brook. Veryfine upgraded their wastewater treatment facility, which was approved by the Department in July 1992 (Hack 2001a). The treatment facility utilizes a combination of biological anaerobic treatment of the high strength wastewater and biological aerobic treatment of the lower strength wastewaters (non-contact cooling water) in sequencing batch reactors for the efficient removal of biological oxygen demand (BOD), Total Suspended Solids and Phosphorous (O'Leary 1993). According to the MA DEP's last inspection (Spring/early summer of 2001), Veryfine wastewater discharge was generally in compliance with their NPDES permit limits (Hack 2001a).

It should also be noted that Littleton is a Phase II Storm Water community. Littleton must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

OTHER:
Middlesex Materials Corporation (aquired from Lone-Star/San-Vel Concrete Company in 1992) is a nonmetallic mineral processing plant (crushed stone, gravel, and sand) located on Ayer Road in Littleton. The raw materials are mined on-site and are crushed, screened, washed and stored on site (Himes and Roscoe 1995). There are no surface process wastewater discharges. As of June 2001 the company had not applied for a stormwater permit.

USE ASSESSMENT:
Aquatic Life

Toxicity

Ambient

Veryfine Products, Inc. submitted toxicity test results for 24 tests conducted between February 1996 and April 2001. Survival of *P. promelas* exposed (7-day) to "Reedy Meadow Brook" water collected approximately 1500 feet upstream of their discharge ranged between 2 and 100%. Survival was less than 50% in eight of the 24 tests conducted that occurred during the winter/spring (January to May) test events. However, since July 1999, minnow survival has not been less than 95% in any of the tests conducted.

Effluent

Veryfine Products, Inc. conducted 24 effluent toxicity tests using *P. promelas* between February 1996 and April 2001 on their treated effluent (Outfall #001) discharge. No acute whole effluent toxicity has been detected (i.e., the LC_{50} have all been $\geq$ 100% effluent) while chronic toxicity has, with one exception, met the CNOEC permit limit of $\geq$ 91% effluent (CNOEC = 100% effluent). In October 1998, the CNOEC test result was 12.5% effluent.

Acute toxicity tests were also conducted on the Veryfine Products, Inc. storm water discharge (Outfall #002). Acute toxicity was not detected during the seven tests conducted between June 1995 and June 1998 by any of the three test organisms (*Ceriodaphnia dubia*, *Daphnia pulex* and *P. promelas*).

Chemistry - water

Veryfine Products, Inc. collected water from "Reedy Meadow Brook" (approximately 1500 feet upstream of their discharge) on 24 occasions between February 1996 and April 2001 for use in their whole effluent toxicity tests. Results from the TOXTD database are summarized below.

pH

Instream pH ranged between 6.1 and 7.7 SU as reported in the Veryfine Products, Inc. toxicity test reports (dilution water collected upstream of their discharge). Seven measurements were less than 6.5 SU.

Suspended Solids

Suspended solids concentrations reported in Veryfine Products, Inc. toxicity test reports were below detection limit (BDL) to 21 mg/L.

Ammonia-Nitrogen

Measurements of ammonia-nitrogen ranged between BDL and 0.8 mg/L.

Total Residual Chlorine (TRC)

No TRC was detected in "Reedy Meadow Brook" as reported in the Veryfine Products, Inc. toxicity test reports.

Hardness

Hardness measurements in the brook ranged from 32 to 112 mg/L.

Based on the instream toxicity testing data indicating good survival of *P. promelas* since July 1999, the Veryfine Products, Inc. whole effluent toxicity test results (the facility is in compliance with their permit limits), it is best professional judgement that the *Aquatic Life Use* be assessed as support in "Reedy Meadow Brook". The use is, however, identified with an "Alert Status" because of the poor survival of *P. promelas* in the winter/spring tests conducted prior to July 1999.

Unnamed Tributary "Reedy Meadow Brook" (MA84B-01) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life*		SUPPORT				
Fish Consumption		NOT ASSESSED				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

* "alert status" issues identified, details in this segment's USE ASSESSMENT section

RECOMMENDATIONS: UNNAMED TRIBUTARY "REEDY MEADOW BROOK" (SEGMENT MA84B-01)

- As part of the WMA 5-year review process, DEP should continue to evaluate Middlesex Materials Corporation (formerly Aggregate Materials Corporation's) compliance with their WMA registration.
- Middlesex Materials Corporation should also contact EPA to determine whether or not they should apply for a stormwater permit and subsequently develop a stormwater pollution prevention plan.
- Continue to evaluate Veryfine Products, Inc. compliance with their WMA registration and/or permit limits.
- Conduct biological monitoring (e.g., benthic macroinvertebrates, fish population, habitat quality) to evaluate the effect(s), if any, of water withdrawals, stormwater runoff, and Veryfine Products, Inc. discharge on aquatic life in "Reedy Meadow Brook" and to confirm the evaluation of the *Aquatic Life Use*.
- When complete, review the results of the hydrological assessment of the Stony Brook subwatershed project to determine future data needs and other action items.

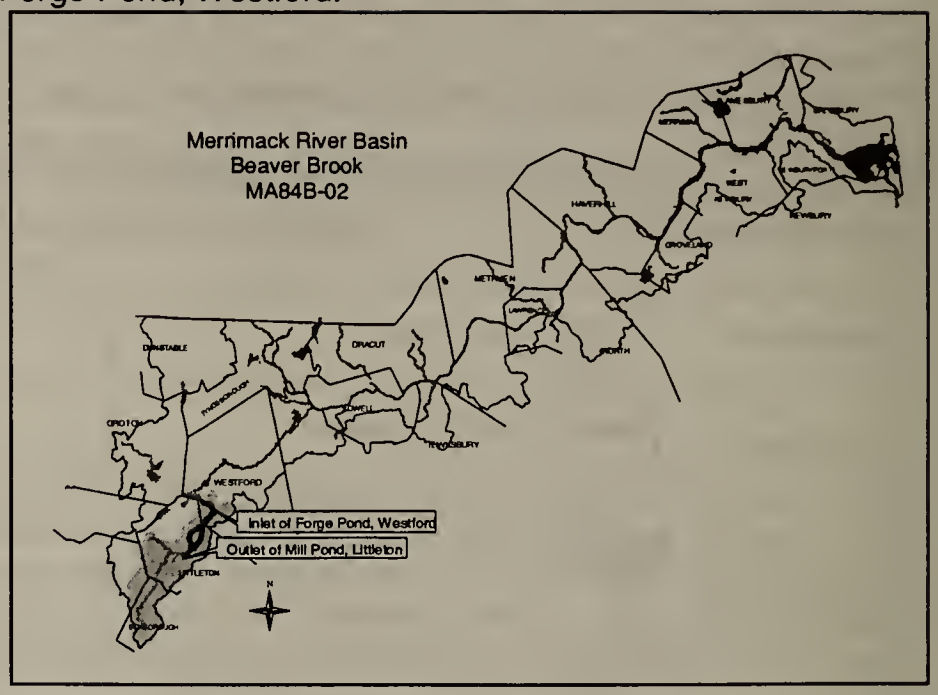
BEAVER BROOK (SEGMENT MA84B-02)

Location: Outlet Mill Pond, Littleton to inlet Forge Pond, Westford.
Size: 4.8 miles.
Classification: Class B

Land-use estimates for the subwatershed (map inset, gray shaded area):

Forest	43%
Residential	22%
Agriculture	9%

This segment is on the 1998 303(d) list of impaired waters for pH, organic enrichment/low DO, pathogens, suspended solids and nutrients (Table 3).



WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Littleton Water Department	2158000	9P21315802	21315803	03G	0.84reg* 0.63per* 1.47total*	1.14*
Westford Water Department	2330000	9P21333001	21333001	333-06G Fletcher well (08G) 330-04G	1.18reg* 0.69per* 1.87total*	1.76*

* indicates system-wide withdrawal; all sources are not necessarily within this segment

NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated surface wastewater discharges in this segment. It should be noted, however, that both Littleton and Westford are Phase II Storm Water communities. These communities must apply for permit coverage for their municipal drainage systems and are required to develop, implement and enforce their storm water management programs by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:

Too little current data are available to assess the designated uses of this segment of Beaver Brook. The MRWC and the Upper Stony Brook Stream Team carried out a shoreline survey along two reaches of this segment of Beaver Brook in May 2000. While no major problems were identified, the team noted a new housing development under construction near the brook during their survey (Carney 2000). A hydrological assessment of the Stony Brook subwatershed has been funded through the Massachusetts Watershed Initiative but to date the project has not been started (Appendix F).

Beaver Brook (MA84B-02) Use Summary Table

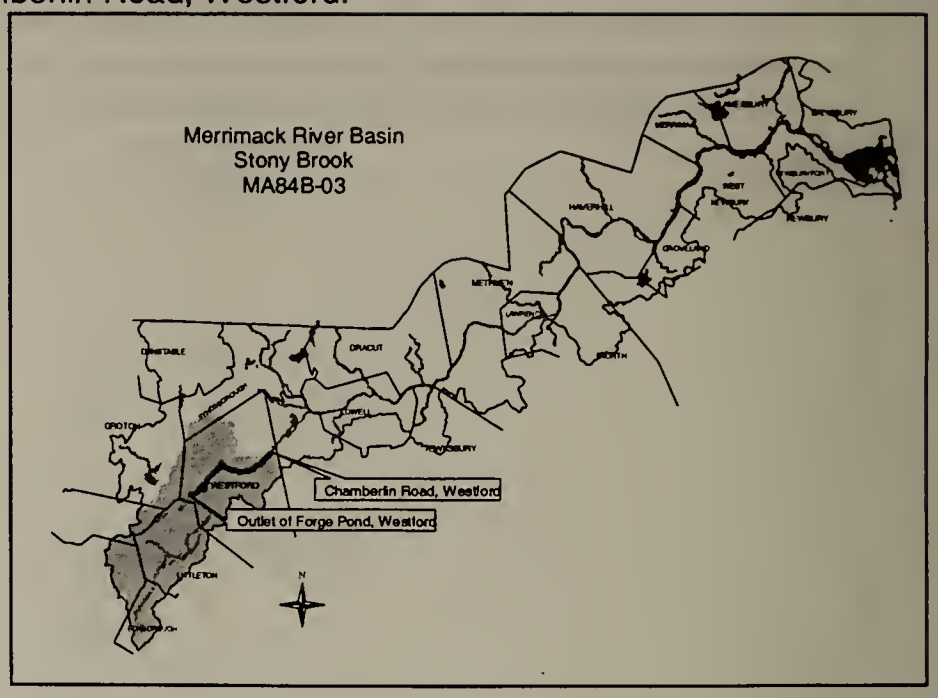
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: BEAVER BROOK (SEGMENT MA84B-02)

- As part of the WMA 5-year review process, DEP should continue to evaluate Littleton and Westford Water Department's compliance with WMA registration and/or permit limits.
- When complete review the results of the hydrological assessment of the Stony Brook subwatershed project to determine future data needs and other action items.

STONY BROOK (SEGMENT MA84B-03)

Location: Outlet Forge Pond, Westford to Chamberlin Road, Westford.
Size: 7.0 miles.
Classification: Class B, Warm Water Fishery.



Land-use estimates (top three)for the subwatershed (map inset, gray shaded area):

Forest	47%
Residential	26%
Open Land	8%

This segment is on the 1998 303(d) list of impaired waters for pH, organic enrichment/low DO, pathogens and turbidity (Table 3).

A hydrological assessment of the Stony Brook subwatershed has been funded through the MWI but to date the project has not been started (Appendix F).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Westford Water Department	2330000	9P21333001	21333001	333-05G 333-01G 330-07G 330-03G 330-02G	1.18reg* 0.69per* 1.87total*	1.76*
Laughton Garden Center, Inc.			31305601	Irrigation pond*	0.07*	0.02*

* indicates system-wide withdrawal; all sources are not necessarily within this segment

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D2):

Westford Anodizing Corporation, Westford is permitted (MA0024414) to discharge (permit issued September 1990) via outfall #001, an average monthly flow of 0.02 MGD (0.03 MGD maximum daily) of treated process wastewater to Stony Brook. The company performs aluminum anodizing, chromate finishing, and plating operations. Their whole effluent toxicity (WET) limit (permit requires testing with *Ceriodaphnia dubia* and *Pimephalas promelas*) is $LC_{50} \geq 100\%$ effluent. In July 1996, the facility was required by EPA, through an Administrative Order, to conduct a Toxicity Identification and Toxicity Reduction Evaluation (TIE/TRE) (Laing 1996). The company was also required by a Consent Agreement to implement a Supplemental Environmental Project to reduce the amount of pollutants discharged to the environment (Hull 2001). In 2000, the company installed a closed-loop system to recirculate their wastewater back to the rinse tanks but they experienced operational problems and only the anodizing wastewater was being recirculated. Violations of the aluminum limits in their discharge remain problematic (Anderson 2000). While the facility has continued to reduce the volume of their discharge (average monthly flow of approximately 0.002 MGD), they continue to be in violation of their WET, silver and aluminum limits (Hull 2001).

Courier Westford, Inc. is permitted (MAG250724) to discharge (permit issued May 1997) non-contact cooling water to Stony Brook.

It should also be noted that Westford is a Phase II Storm Water community. Westford must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT:

AQUATIC LIFE

Biology

In July 1999 DWM conducted an RBP III benthic macroinvertebrate survey (station SB02) of Stony Brook downstream from Brookside Road in Westford at the downstream end of this segment (Appendix C). The benthic macroinvertebrate data were found to be 53% comparable (to the Fish Brook regional reference station (station FB00) in the Ipswich River Basin. The community was dominated by filter-feeders (Hydropsychidae and the filter-feeding mussel - *E. complanata*), which was indicative of the effects of moderate enrichment. Based on the RBP III analysis, the benthic community was slightly impacted.

Habitat and Flow

During the benthic macroinvertebrate survey in Stony Brook (station SB02) significant deposits of sand and finer sediments were observed throughout the reach. Sediment deposition, substrate embeddedness in riffle/run areas, and reduced base-flow conditions contributed most to reductions in habitat scores (Appendix C).

Toxicity

Ambient

Westford Anodizing collects Stony Brook water (approximately 50 feet upstream of their discharge near Broadway Street in the village of Graniteville, Westford) for use as dilution water in their whole effluent toxicity tests. Between March 1997 and March 2001, survival of *C. dubia* and *P. promelas* exposed (48-hour) to Stony Brook was good ($\geq$ 95%).

Effluent

Westford Anodizing conducted six acute toxicity tests on their effluent using both *C. dubia* and *P. promelas* between March 1997 and March 2001on their treated effluent (Outfall #001) discharge. Whole effluent LC_{50}'s ranged between 19 and >100 % effluent. *C. dubia* has consistently been the more sensitive test organism. The facility did not meet its whole effluent toxicity limit in three of the six test events.

Chemistry – water

Westford Anodizing collected water from Stony Brook water (approximately 50' upstream of their discharge on six occasions between March 1997 and March 2001 for use as dilution water in their whole effluent toxicity tests. Data from these reports (maintained in the TOXTD database) are summarized below.

pH

Instream pH ranged between 6.8 and 7.4 SU.

Suspended Solids

Suspended solids concentrations were all BDL.

Ammonia-Nitrogen

Measurements of ammonia-nitrogen were all BDL.

Total Residual Chlorine

TRC was below the minimum quantification level of 0.05 mg/L.

Hardness

Hardness measurements of Stony Brook ranged from 45 to 56 mg/L.

Based on both the instream toxicity testing data indicating good survival of both *C. dubia* and *P. promelas* exposed to Stony Brook and the limited water quality data, the *Aquatic Life Use* is assessed as support for the upper 1.8 miles of this segment of Stony Brook (upstream of the Westford Anodizing discharge). The *Aquatic Life Use* is, however, assessed as partial support for the lower 5.2 miles of the stream based primarily on the benthic macroinvertebrate community analysis (slight impairment) and best professional

judgement. The effects of moderate enrichment were evidenced by the dominance of a filter-feeding benthic community although habitat quality degradation is also a suspected cause of impairment in this portion of Stony Brook. The aquatic communities in the brook are also considered threatened for one mile downstream from the Westford Anodizing discharge because of acute whole effluent toxicity. In July 1996, the facility was required by EPA (Administrative Order) to conduct a TIE/TRE (Laing 1996). Although the company installed a closed-loop system and has worked to reduce the volume and amount of pollutants in their wastewater discharge, they have had operational problems and continue to violate their NPDES permit (WET, aluminum and silver).

AESTHETICS

A shoreline survey along portions of this segment of Stony Brook was carried out by the MRWC and the Lower Stony Brook Stream Team volunteers in April 2000. While no major problems were identified, the team identified isolated areas of trash/debris and a few embankments with slight erosion problems. The shoreline survey data is available in the Lower Stony Brook Watershed 2000 Shoreline Survey Report (Fullford *et al.* 2000).

Too few data were available to assess the status of the *Aesthetics Use*, therefore this use was not assessed. Because of isolated areas of trash and debris, however, this use is identified with an "Alert Status".

Stony Brook (MA84B-03) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life*		SUPPORT upper 1.8 miles PARTIAL SUPPORT 5.2 miles	Effluent toxicity, organic enrichment, unknown	Habitat and flow alteration	Industrial point source, unknown	
Fish Consumption		NOT ASSESSED				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics*		NOT ASSESSED				

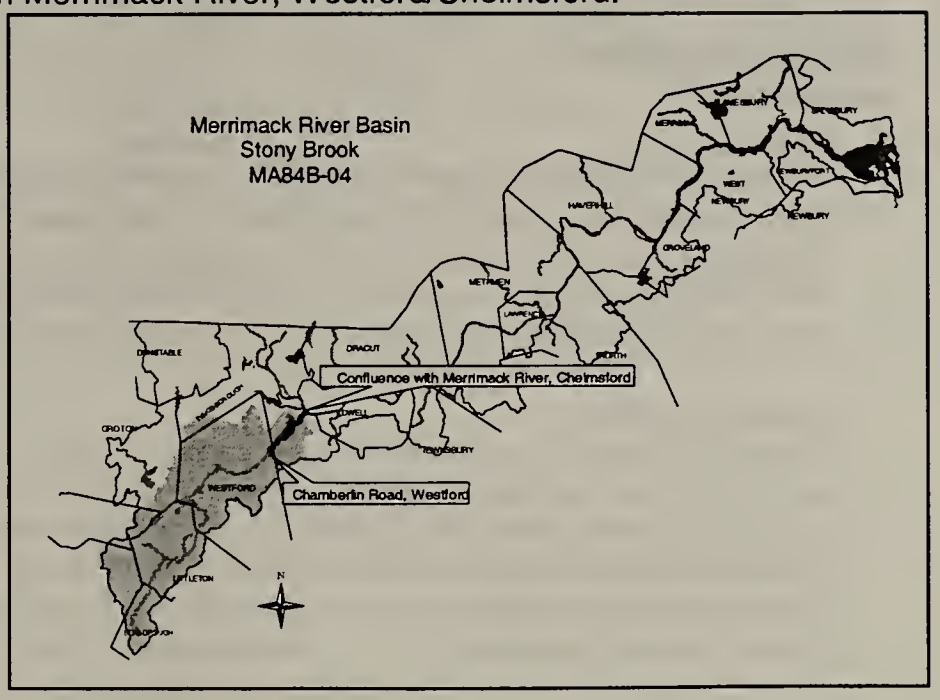
* "alert status" issues identified, details in this segment's USE ASSESSMENT section

RECOMMENDATIONS: STONY BROOK (SEGMENT MA84B-03)

- Conduct a preliminary analysis to identify potential sources of sediment (e.g., sand and gravel operations) to Stony Brook. Develop and implement BMPs to reduce impacts of stormwater runoff.
- When complete review the results of the hydrological assessment of the Stony Brook subwatershed project to determine future data needs and other action items.
- As part of the WMA 5-year review process, DEP should continue to evaluate Westford Water Department's compliance with WMA registration and/or permit limits and Laughton Garden Center's compliance with their WMA registration.
- Develop and reissue Westford Anodizing Corporation, Westford NPDES permit (MA0024414) until such a time as their closed-loop system becomes fully operational. The USEPA has issued another Administrative Order to Westford Anodizing Corporation to conduct additional toxicity evaluations to identify the source of the continued WET violations.
- Courier Westford, Inc. (MAG250724) should reapply for their NPDES permit.
- Work with the Lower Stony Brook Stream Team to implement their priority actions (Fullford *et al.* 2000).

STONY BROOK (SEGMENT MA84B-04)

Location: Chamberlin Road to confluence with Merrimack River, Westford/Chelmsford.
Size: 3.3 miles.
Classification: Class B, Warm Water Fishery.



Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	43%
Residential	30%
Open Land	7%

An evaluation of land-use within the Stony Brook Watershed was recently completed by the Merrimack River Watershed Council (Monnelly and Strauss 2001a). It should also be noted that a Stony Brook Impervious Surfaces Pilot Project is scheduled to begin in the Fall 2001 to help communities implement BMPs to minimize and mitigate current and future impacts of impervious surfaces (Monnelly and Strauss 2001a).

This segment is on the 1998 303(d) list of impaired waters for pH, pathogens, and nutrients (Table 3). A hydrological assessment of the Stony Brook subwatershed has been funded through the MWI but to date the project has not been started (Appendix F).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Chelmsford Water District	3056000		31305603	056-03G 056-06G 056-08G 056-10G 056-12G	1.73*	1.82**
North Chelmsford Water District	3056002		3130562	056A01G 056A02G 056A03G 056-04G	0.94	0.77
Laughton Garden Center, Inc.			31305601	Well #2* Well #1*	0.07*	0.02*

* indicates system-wide withdrawal; all sources are not necessarily within this segment, ** withdrawal did not exceed registration amount by more than 0.1 MGD (WMA threshold)

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D2):

Fletcher Granite Company, Westford is permitted (MA0020231) to discharge (permit issued September 1997) overflow from the quarry supply pond via outfall serial # 001 and process water from cutting mill via outfall #003 to Gilson Brook, a tributary to this segment of Stony Brook. Quarry water made up of rainwater and groundwater is pumped to the company's water supply pond. The pond water is used as the source of once-through cooling water (lubricating and cooling wire saws that cut the granite). The cooling water is discharged into a series of settling ponds and is then recycled back to the water supply pond. An average of 0.1 MGD is discharged via outfall # 001. Approximately 0.05 MGD is discharged via outfall #003 from the cutting mill (wastewater contains fine stone dust) into a settling lagoon that overflows to Gilson Brook.

It should also be noted that both Westford and Chelmsford are Phase II Storm Water communities. These communities must apply for permit coverage for their municipal drainage systems and are required

to develop, implement and enforce their storm water management programs by March 2003 (Domizio 2001).

USE ASSESSMENT:

AQUATIC LIFE

Biology

In July 1999 DWM conducted an RBP III benthic macroinvertebrate survey (station SB02) of Stony Brook downstream from Brookside Road in Westford just upstream of this segment of Stony Brook (Appendix C). The benthic macroinvertebrate data were found to be 53% comparable (to the Fish Brook regional reference station (station FB00) in the Ipswich River Basin. Based on the RBP III analysis, the benthic community, dominated by filter-feeding organisms, was slightly impacted.

Habitat and Flow

During the benthic macroinvertebrate survey in Stony Brook (station SB02) significant deposits of sand and finer sediments were observed throughout the reach. It should be noted, however, that this reach is located upstream of Gilson Brook (the receiving stream for the Fletcher Granite Company -- a potential source of fine sediment/stone dust to Stony Brook). Sediment deposition, substrate embeddedness in riffle/run areas, and reduced base-flow conditions contributed most to reductions in habitat scores (Appendix C).

Chemistry – sediment

USGS collected sediment from Stony Brook downstream from the School Street bridge in Chelmsford in July 1999 and again in August 2000 as part of their Toxics Substances Hydrology Program (an extension of the National Mercury Pilot Study), Urban Land Use Gradient Study (part of the NAWQA program) and the DEP Merrimack Valley Fish Study (Chalmers 2001). The sediment was analyzed for trace elements and organic compounds. These data, however, are not yet available.

Chemistry – tissue

USGS collected red breasted sunfish from Stony Brook downstream from the School Street bridge in Chelmsford in August 2000 as part of their Toxics Substances Hydrology Program (an extension of the National Mercury Pilot Study), Urban Land Use Gradient Study (part of the NAWQA program) and the DEP Merrimack Valley Fish Study. The five fish fillet composite samples were analyzed for trace metals in tissue, organochlorine pesticides, and total PCB. These data, however, are not yet available (Chalmers 2001).

The *Aquatic Life Use* is assessed as partial support for the 3.3 miles of this segment of Stony Brook based primarily on the benthic macroinvertebrate community analysis (slight impairment) and best professional judgement. The effects of moderate enrichment were evidenced by the dominance of a filter-feeding benthic community although habitat quality degradation is also a suspected cause of impairment in this portion of Stony Brook.

AESTHETICS

The MRWC and the Lower Stony Brook Stream Team volunteers carried out a shoreline survey along portions of this segment of Stony Brook in April 2000. No major problems were identified (Fullford *et al.* 2000).

Too few data (i.e., spatial coverage) were available to assess the status of the *Aesthetics Use,* therefore this use was not assessed.

Stony Brook (MA84B-04) Use Summary Table

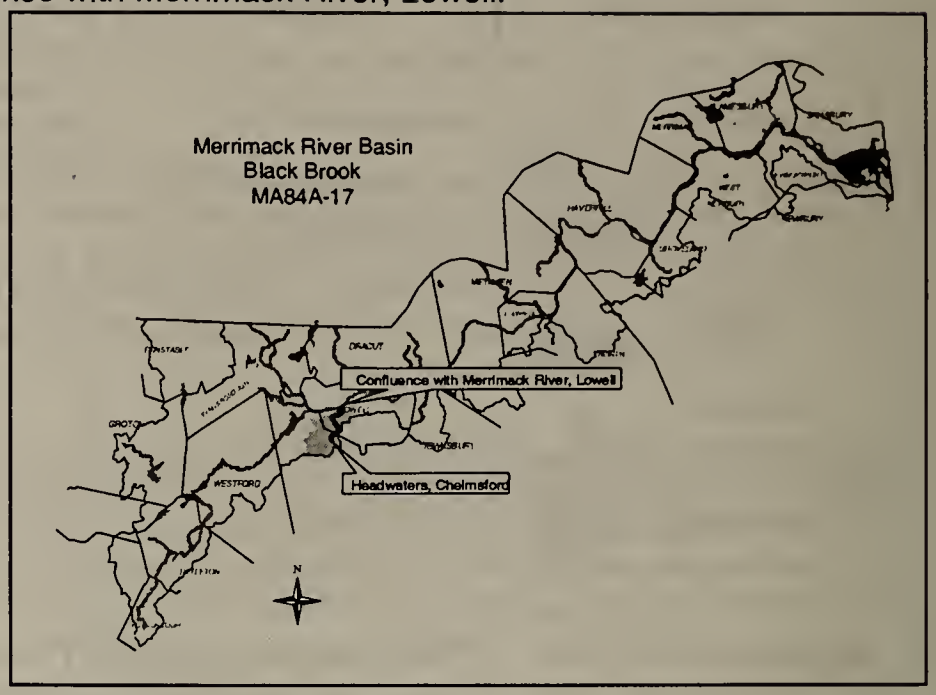
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	Organic enrichment, unknown	Habitat and flow alteration	unknown	
Fish Consumption		NOT ASSESSED				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: STONY BROOK (SEGMENT MA84B-04)

- Excerpted from the Biological Technical Memorandum (Appendix C)
  Eutrophic conditions of upstream impoundments (e.g., Forge and Mill ponds), as well as direct nutrient/organic loadings to Stony Brook itself probably account for the organically enriched conditions reflected in the aquatic community at SB02. In addition to water quality constraints, habitat degradation (especially instream deposition) probably compromises biological integrity here as well—though to a lesser degree. An investigation of land-use and possible nonpoint source pollution along Stony Brook upstream from SB02 may help to isolate sources of nonpoint source-related stressors. A stream clean-up effort would address the trash that apparently enters the river from the Brookside Road crossing, and further dumping of trash should be strongly discouraged.
- Conduct a preliminary analysis to identify potential sources of sediment (e.g., sand and gravel operations) to Stony Brook. Develop and implement best management practices to reduce impacts of stormwater runoff where necessary.
- When complete review the results of the hydrological assessment of the Stony Brook subwatershed project to determine future data needs and other action items.
- As part of the WMA 5-year review process, DEP should continue to carefully monitor Chelmsford Water District compliance with their WMA registration limit (close to exceeding registration threshold) as well as North Chelmsford Water District's compliance with their WMA registration limit.
- Work with the Lower Stony Brook Stream Team to implement their priority actions (Fullford *et al.* 2000).
- Review the MRWC Stony Brook Watershed Assessment and support their efforts to protect the Stony Brook Watershed (Monnelly and Strauss 2001a).
- Develop and reissue Fletcher Granite Company, Westford's permit (MA0020231). Determine whether or not stormwater runoff needs to be regulated (either part of individual or general multi-sector stormwater permit).

BLACK BROOK (SEGMENT MA84A-17)

Location: Headwaters, Chelmsford to confluence with Merrimack River, Lowell.
Size: 3.15 miles.
Classification: Class B.



Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Residential	83%
Forest	7%
Open Land	3%

This segment is on the 1998 303(d) list of impaired waters, needing confirmation, for pathogens, turbidity, siltation and unknown toxicity (Table 3).

The Lowell Municipal Landfill on Westford Street, Lowell has been closed (capped) since 1992 and currently undergoes semi-annual environmmental monitoring (surface and ground water). Surface water samples are collected at the culvert at Princeton Blvd., from the primary basin for leachate collection, from a pond at the landfill, from an adjacent stream, and from wetlands located west of the landfill. Groundwater monitoring indicates elevated levels of volatile organic compounds down gradient of the landfill. Other compounds are below maximum contaminant levels (Casella 2001).

It should also be noted that Chelmsford has received SRF funding to implement their Long Term plan to eliminate Title V systems and install sewers in the community (Barber 2001a).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2104 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Chelmsford Water District	3056000		31305603	056-07G* 056-14G*	1.73*	1.82**

* indicates system-wide withdrawal; all sources are not necessarily within this segment, ** withdrawal did not exceed registration amount by more than 0.1 MGD (WMA threshold)

NPDES WASTEWATER DISCHARGE SUMMARY:

There are currently no known regulated surface water discharges to Black Brook. A storm water permit may be required, however, for the city of Lowell's Municipal Landfill.

It should be noted that Chelmsford is a Phase II Storm Water community. Chelmsford must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:

The most recent benthic macroinvertebrate survey in Black Brook was conducted in August 1990. Two stations, BB06 (near the confluence with the Middlesex Canal next to the Mount Pleasant Golf Course) and BB05 (Westford Street Bridge in Lowell downstream from the Lowell Landfill) were sampled by DEP (Smith *et al.* 1990). The RBP II analysis at both stations suggested moderate impacts. The Lowell Landfill was identified as a major source of impairment. Problems identified included severe sedimentation, trash/debris, and sediment quality degradation (oil released from disturbed sediment). No recent data have been collected, therefore all uses are not assessed. Both the *Aquatic Life* and *Aesthetic* uses, however, are identified with an "Alert Status".

Black Brook (MA84A-17) Use Summary Table

Aquatic Life*	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics*
Not Assessed				

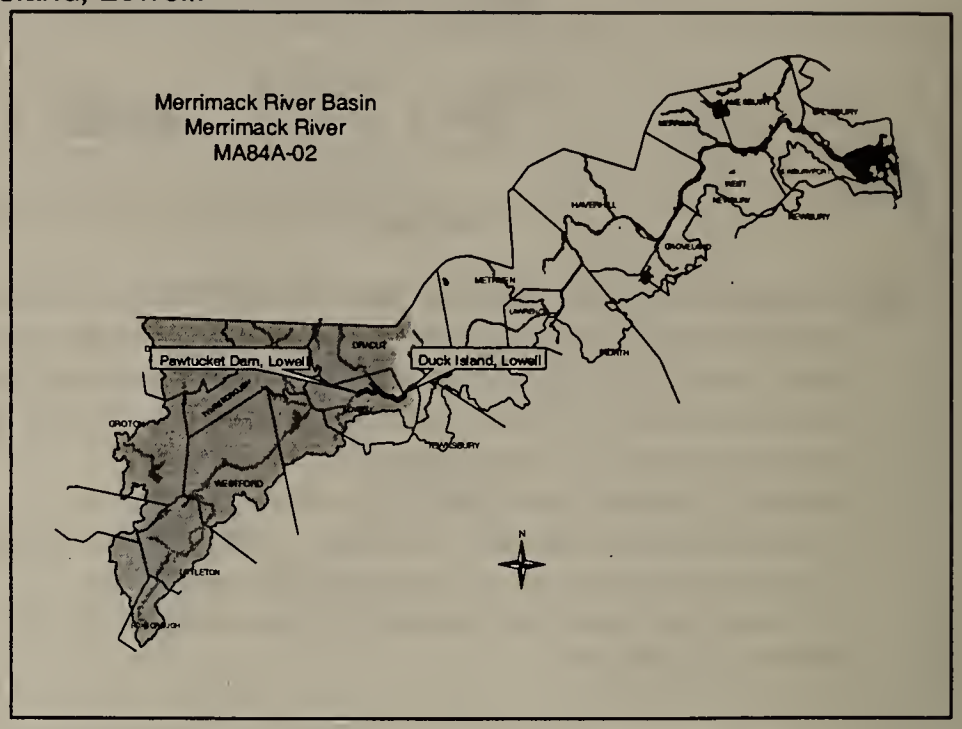
* "alert status" issues identified, see Use Assessment Summary

RECOMMENDATIONS: BLACK BROOK (SEGMENT MA84A-17)

- As part of the WMA 5-year review process, DEP should continue to carefully monitor Chelmsford Water District compliance with WMA registration limits (close to exceeding registration threshold).
- Determine if a storm water permit is required for the city of Lowell's Municipal Landfill. Develop and implement a SWPP if necessary.
- Instream biological monitoring should be conducted.
- Conduct instream bacteria sampling to evaluate the effectiveness of Chelmsford's actions to eliminate Title V systems and install sewers in the community.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

MERRIMACK RIVER (SEGMENT MA84A-02)

Location: Pawtucket Dam, Lowell to Duck Island, Lowell.
Size: 2.8 miles.
Classification: Class B, Warm Water Fishery, Treated Water Supply, CSO.



This segment of the Merrimack River encompasses the Pawtucket Canal System. The Concord River also joins the Merrimack River just upstream of the Hunts Falls Bridge.

Land-use estimates (top three) for the Massachusetts portion of this subwatershed less the South Branch Souhegan River area (map inset, gray shaded area):

Forest	44%
Residential	30%
Open Land	7%

This segment is on the 1998 303(d) list of impaired waters for pathogens and nutrients (Table 3).

The Pawtucket Dam in Lowell, MA has three fish passages. There is a fish elevator (44 feet) at the Eldred L. Field Hydroelectric plant used for upstream runs, a fish ladder at the dam, and a fish bypass at the plant for downstream runs. The MA Division of Fisheries and Wildlife observes these passages for recordable counts of fish species (Nutter 2001). Boott Hydropower, Inc. controls the flow in the Pawtucket Canal.

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Western Avenue Dyers, LP*		9P31316001		Pawtucket Canal	1.93	0.37

* The water used for steam generation at the Lowell Cogeneration Company is supplied by Western Ave. Dyers.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLES D1 AND D2):

Boott Hydropower Company, Inc. is permitted to discharge (permit coverage effective September 2000) non-contact cooling water via three locations as described below:

> Eldred L. Field Hydroelectric Project (MAG250163) 0.6 MGD NCCW to the Merrimack River, John Street Power Station (MAG250950) 0.006 MGD NCCW to the Merrimack River, and Hamilton Power Station (MAG250949) 0.00144 MGD of NCCW via the Hamilton Canal to this segment of the Merrimack River.

Lowell Cogeneration Company is permitted (MA0031071) to discharge (permit issued August 1987) 0.115 MGD (maximum daily) of combined cooling tower blowdown, boiler blowdown, and demineralization wastes via outfall # 001 and stormwater runoff, building floor drains, equipment drains and intermittent boiler blowdown via outfall #002 to the Pawtucket Canal on the Merrimack River. The estimated 7Q10 flow in the canal used to develop the permit is 50 cfs. The permit limits for the discharge include temperature, TRC and other biofowling chemicals and $LC_{50} \geq 50\%$ effluent using two test organisms, *Daphnia pulex* and *Pimphales promelas*. The facility also conducted an instream temperature study. The company reapplied for their NPDES permit in 1992 as well as for an individual stormwater permit.

Lowell National Historic Park, Boott Cotton Mills Museum is permitted (MAG250732) to discharge (permit coverage effective November 2000) 0.36 MGD of non-contact cooling water via the Eastern Canal into this segment of the Merrimack River.

Lowell Regional Water and Wastewater Utilities (LRWWU) (MA0100633) is permitted to discharge via nine Diversion Structures (upstream to downstream) along this segment of the Merrimack River as indicated below:

Walker Street CSO Diversion Structure
Beaver Brook CSO Diversion Structure (to Beaver Brook)
West Street CSO Diversion Structure
Tilden Street CSO Diversion Structure
Read Street CSO Diversion Structure
Warren Street CSO Diversion Structure (to Concord River)
Merimack River CSO Diversion Structure
Barasford Avenue CSO Diversion Structure
First Street CSO Diversion Structure

OTHER:

FERC:

The Lowell Project Number 2790 owned by the Boott Hydropower Inc., is located at the Pawtucket Dam on the Merrimack River. The project generates 24823 Kilowatts. The FERC license was issued April 1983 and expires April 2023 (Kaye 2000). The main dam is 16' in height and is 1,093' in length. The project includes five powerhouses (three of which have general NPDES permits for non-contact cooling water described above) along the canal system, the largest being the new Eldred L. Field Powerhouse which is capable of generating 17,308 kW. The project operates as a run-of-river facility and releases a minimum flow of 905 cfs to protect downstream resources. The minimum flow is provided through the operation of the units (Enrico 2000a).

The Appleton Trust Project Number 9300 owned by James T. Lichoulas is located at the Hamilton Canal on the Merrimack River. The project has the capacity to generate 346 Kilowatts. The FERC license was issued July 1986 and expires June 2026 (Kaye 1999). There is one powerhouse with two turbines that are connected to a single generator. The project does not include any dam; it uses the differential in water levels between the Hamilton and Pawtucket Canals. The 13' head is created by the Swamp Lock Dam which is part of the Lowell Project Number 2790. According to the 1999 operation report, the project has not been operational since January 1996 (in need of repairs) (Kaye 1999).

USE ASSESSMENT:

AQUATIC LIFE

Habitat and Streamflow

The bypass reach of the Merrimack River downstream from the Pawtucket Dam through Pawtucket Falls to the confluence with the Lowell Project tailrace (0.7 miles) is periodically dry (during low flow conditions). The riverbed along the Pawtucket Falls reach is exposed when the flow is diverted solely through the Northern canal system (Enrico 2001).

Biology

Anadromous fish counts for the Merrimack River at the Pawtucket Dam in Lowell in 2001 are as follows (USFWS 2001e):

Altantic Salmon: (not applicable, they are taken out by USFWS at the Essex Dam)
American Shad: 7,740
River Herrings (both blueback herring and alewife): 58

Chemistry – water

The USGS, as part of their National Water-Quality Assessment (NAWQA) Program in the New England Coastal Basins (Maine, Massachusetts, New Hampshire, and Rhode Island) study unit, conducted monthly water quality sampling in the Merrimack River between October 1998 and September 2000 at their gaging station 01100000 at Lowell, MA. These data are published in the

Water Resources Data Massachusetts and Rhode Island Water Year 1999 and 2000 reports (Socolow *et al.* 2000 and Socolow *et al.* 2001).

DO
Instream DO ranged between 5.8 and 14.3 mg/L. DO data for August 1999 have been censored by USGS because of the presence of an electrical charge at the sampling location that interfered with their DO meter (Zimmerman 2001).

Temperature
The maximum temperature (20 July 1999) was 26.7°C.

pH
Instream pH ranged between 6.6 and 7.5 SU (24 measurements).

Suspended Solids
Measurements of suspended sediment ranged between 2 and 86 mg/L. Of the 25 measurements, three exceeded 25 mg/L and they were all associated with storm/runoff conditions.

Ammonia-Nitrogen
Total ammonia and organic nitrogen (mg/L as N) ranged between 0.30 and 0.76 mg/L. All of these measurements were below 2.08 mg/L N (chronic instream criterion for ammonia at pH of 7.5 and temperature of 26°C (USEPA 1999).

Phosphorus
Total phosphorus concentrations ranged between 0.034 to 0.217 mg/L with a mean of 0.08 mg/L.

Chemistry – sediment
USGS collected sediment from the Merrimack River near their Lowell gage in June 1999 as part of their Toxics Substances Hydrology Program (an extension of the National Mercury Pilot Study), Urban Land Use Gradient Study (part of the NAWQA program) and the DEP Merrimack Valley Fish Study. The sediment was analyzed for trace elements and organic compounds. These data, however, are not yet available (Chalmers 2001).

Chemistry – tissue
USGS collected largemouth and smallmouth bass from the Merrimack River near their Lowell gage in June 1999 as part of their Toxics Substances Hydrology Program (an extension of the National Mercury Pilot Study), Urban Land Use Gradient Study (part of the NAWQA program) and the DEP Merrimack Valley Fish Study. A seven fish fillet composite largemouth bass sample was analyzed for trace metals in tissue and a seven fish whole body composite sample of small mouth bass was analyzed for organochlorine pesticides and total PCB. These data, however, are not yet available (Chalmers 2001).

The USFWS conducted a screening-level survey to determine the state of contamination of selected priority pollutants (e.g., PCB, lead, mercury, cadmium, copper,etc.) in whole fish samples collected from the mainstem Merrimack River in 1982 and 1985 (Major and Carr 1991). The study found that PCB concentrations in whole fish samples from the mainstem Merrimack River in both New Hampshire and Massachusetts ranged from 0.09 to 4.1 ppm wet weight.

There is a 0.7 mile bypass reach in the Merrimack River (Pawtucket Falls) which is periodically dewatered as a result of the operation of the FERC Lowell Project Number 2790. This reach of the river is assessed as non-support for the *Aquatic Life Use* as a result of this flow alteration (hydromodification). The lower 2.1-mile reach of this segment is not assessed for the *Aquatic Life Use* (too little current data available to assess the effects of multiple NPDES discharges and/or nonpoint sources of pollution). However, because of elevated concentration of PCBs documented in whole fish collected in the Merrimack River in 1982 and 1985 (Major and Carr 1991) as well as from downstream reaches of the river in 1998 (McDonald 1999), it is best professional judgment that the *Aquatic Life Use* for this segment be identified with an "Alert Status".

FISH CONSUMPTION

DPH has issued a fish consumption advisory due to mercury contamination for the Merrimack River - all towns between Tyngsborough and Methuen (MDPH 2001a):

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat white sucker or largemouth bass from this waterbody."
2. "The general public should limit consumption of white sucker and largemouth bass to two meals per month."

Because of the site-specific MDPH fish consumption advisory, which encompasses this segment of the Merrimack River, the *Fish Consumption Use* is assessed as non-support due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

PRIMARY* AND *SECONDARY CONTACT RECREATION

The public beach at the Lowell Heritage State Park, located just upstream of this segment of the Merrimack River, has been frequently closed to swimming as a result of elevated bacteria counts.

While LRWWU is implementing CSO pollution abatement strategies, nine CSOs currently discharge to this segment of the Merrimack River. These outfalls presently activate up to 37 times annually, and result in the discharge of approximately 352 million gallons of CSO during a year with typical precipitation. According to Camp Dresser and McKee's (CDM) June 2001 draft LRWWU Long-term CSO control plan "...the Warren Street CSO Structure (to the lower Concord River) has been shown to contribute the largest volume of CSO discharges per year at 202 MG, which represents 57 percent of the total average annual volume for the collection system. Collectively, four CSOs, the Warren Street, Beaver Brook, Barasford Avenue, and Merrimack River Diversion Structures contribute approximately 96 percent of the average annual CSO volume discharged by the Lowell system. The Merrimack River, Warren Street, and Beaver Brook CSO Diversion Structures are also the most active CSOs, with average discharges of about 30-37 times per year (about 3 times per month). Typically, the Walker Street and First Street CSO Diversion Structures discharge CSOs less than once per year" (CDM 2001a).

Fecal coliform bacteria samples were also collected just upstream of the LRWWU discharge by DEP as part of a DEP/WES microbiological study of the Merrimack River (Appendix G). Of the four samples collected between August 1999 and April 2001, the highest count was 1200 cfu/100mLs (Appendix G, Table G1). Two of the four counts (both of which represented "dry weather" sampling conditions) exceeded 400 cfu/100 mls.

Based on the information described above and best professional judement, the *Primary Contact Recreational Use* is assessed as non-support for this segment of the Merrimack River. Because of the limited current quality assured data, the *Secondary Contact Recreational Use* is not assessed but is identified with an "Alert Status". Sources of bacteria include the CSO discharges in Lowell and other upstream communities as well as urban runoff.

AESTHETICS

The Merrimack River Watershed Council reports that this segment of the Merrimack River is generally aesthetically pleasing (Goodno 2001). This use is however identified with an "Alert Status" because of the CSO discharges.

The *Aesthetics Use* is assessed as support.

Merrimack River (MA84A-02) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life*		NON SUPPORT upper 0.7 miles NOT ASSESSED lower 2.1 miles	Flow alteration		Hydromodification	
Fish Consumption		NON SUPPORT	Mercury		Unknown	Atmospheric Deposition
Primary Contact		NON SUPPORT	Pathogens		CSO	Urban runoff
Secondary Contact*		NOT ASSESSED				
Aesthetics*		SUPPORT				

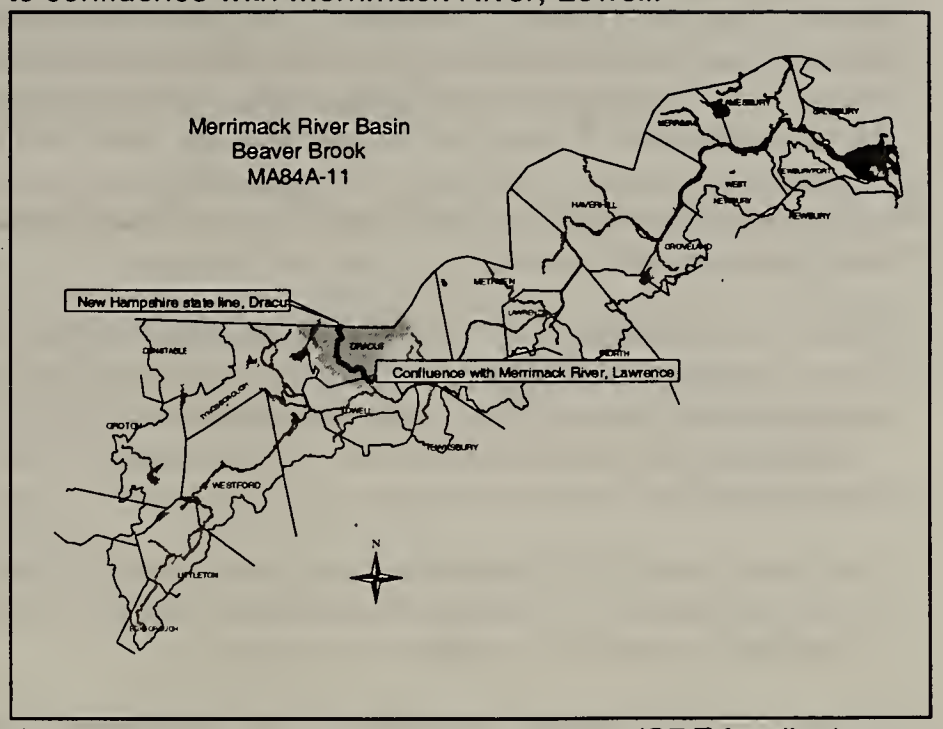
* "alert status" issues identified, details in this segment's USE ASSESSMENT section

RECOMMENDATIONS: MERRIMACK RIVER (SEGMENT MA84A-02)

- Require minimum flow into the bypass reach of the Merrimack River (through Pawtucket Falls) as part of the reissuance of the Lowell Project 2790 FERC license.
- Evaluate the Draft and Final Long-Term CSO Control Plans for LRWWU and, when approved, require that LRWWU implement CSO controls expeditiously to address these known sources of pollution.
- Collect water quality data, including bacteria data, to evaluate the effectiveness of the LRWWU CSO abatement projects as well as those being implemented in New Hampshire CSO communities.
- Continue to review water quality data (including any data from the ACOE project), to identify hotspots and integrate CSO and stormwater management activities to maximize water quality benefits.
- Develop and reissue Lowell Cogeneration Company NPDES permit (MA0031071). As part of the development of this permit evaluate the results of their instream temperature study and review biofowling control techniques.
- As part of the WMA 5-year review process, DEP should continue to evaluate Western Avenue Dyers, LP compliance with their WMA permit.
- Conduct additional monitoring (e.g., passive water column PCB samplers, whole fish tissue), to determine the extent, and if necessary, source(s) of PCB contamination.

BEAVER BROOK (SEGMENT MA84A-11)

Location: New Hampshire state line Dracut to confluence with Merrimack River, Lowell.
Size: 4.2 miles.
Classification: Class B, Cold Water Fishery



Land-use estimates (top three) for the Massachusetts portion of this subwatershed (map inset, gray shaded area):

Residential	42%
Forest	38%
Agriculture	7%

This segment is on the 1998 303(d) list of impaired waters for pathogens (Table 3). It should also be noted that the Beaver Brook watershed (including the New Hampshire area) is under heavy development pressure. Route I-93 is also scheduled for expansion (Goodno 2001). Dracut has also been sewering areas (SRF funding) to eliminate failing septic systems (Barber 2001a).

Monthly water quality monitoring in Beaver Brook was conducted by the Lowell Regional Wastewater Utility in 1999 (Murphy 1999).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Dracut Water District	3079000		31307902	079-02G* 079-03G*	0.79*	Unavailable (Data considered unreliable)

* indicates system-wide withdrawal; all sources are not necessarily within this segment

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D1):

Lowell Regional Water and Wastewater Utility is permitted (MA0100633) to discharge (permit issued August 1997) combined sewer overflow from outfall serial # 007 – Stormwater Diversion Structure or SDS #2 to Beaver Brook. According to CDM's draft Lowell Regional Long-term CSO Control Plan, the Beaver Brook CSO Structure is one of the four CSOs that collectively contribute approximately 96 percent of the average annual CSO volume discharged by the Lowell system. The Beaver Brook CSO Diversion Structure discharges on average 30-37 times per year (about three times per month) (CDM 2001a). The draft Long-Term Control Plan, submitted to the MA DEP and EPA, is currently under review (Casella 2001).

It should also be noted that Dracut and Lowell are Phase II Storm Water communities. These communities must apply for permit coverage for their municipal drainage systems and are required to develop, implement and enforce their storm water management programs by March 2003 (Domizio 2001).

USE ASSESSMENT:

AQUATIC LIFE

Biology

In July 1999 DWM conducted an RBP III benthic macroinvertebrate survey (station BB01) of Beaver Brook downstream from Pleasant Street in Dracut (Appendix C). The benthic macroinvertebrate data were found to be 74% comparable to the Fish Brook regional reference station (station FB00) in the Ipswich River Basin. Based on the RBP III analysis, the benthic community was slightly impacted.

Habitat and Flow

Serious habitat degradation in the form of instream sedimentation in Beaver Brook (station BB01) was observed by DWM during the benthic macroinvertebrate survey. In addition to erosion/sedimentation, instream and riparian trash deposits of construction related material and other anthropogenic debris was evident throughout the sampling reach. Petroleum odors and instream turbidity downstream from the confluence with Peppermint Brook were also identified (Appendix C).

Based on the habitat quality and the benthic macroinvertebrate community analysis, the *Aquatic Life Use* is assessed as partial support.

PRIMARY* AND *SECONDARY CONTACT RECREATIONAL AND AESTHETIC USES

The Lowell Regional Water and Wastewater Utility's Beaver Brook CSO Diversion Structure, one of the city's four largest CSOs, discharges on average 30-37 times per year (about 3 times per month) (CDM 2001a). The outfall is located approximately 0.1 miles upstream of the confluence with the Merrimack River.

Petroleum odors and instream turbidity were noted by DWM entering Beaver Brook via Peppermint Brook (Appendix C). Dumping of excavation-related debris (e.g., concrete/asphault, sand) also degraded the aesthetic quality of the brook.

The upper 3.7 mile reach of Beaver Brook is not assessed for the *Primary* and *Secondary Contact Recreational* or *Aesthetic* uses. Because of the degraded aesthetic quality in Beaver Brook, as well as the presence of an active CSO discharge, the lower 0.5-mile reach is assessed as non-support for the *Recreational* and *Aesthetic* uses.

Beaver Brook (MA84A-11) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	Habitat degradation	Organic enrichment, nutrients	Habitat modification	Upstream impoundments
Fish Consumption		NOT ASSESSED				
Primary Contact		NOT ASSESSED upper 3.7 miles NON SUPPORT Lower 0.5 miles	Objectionable deposits, turbidity, oil		Dumping, CSO	
Secondary Contact		NOT ASSESSED upper 3.7 miles NON SUPPORT Lower 0.5 miles	Objectionable deposits, turbidity, oil		Dumping, CSO	
Aesthetics		NOT ASSESSED upper 3.7 miles NON SUPPORT Lower 0.5 miles	Objectionable deposits, turbidity, oil		Dumping, CSO	

* "alert status" issues identified, details in this segment's USE ASSESSMENT section

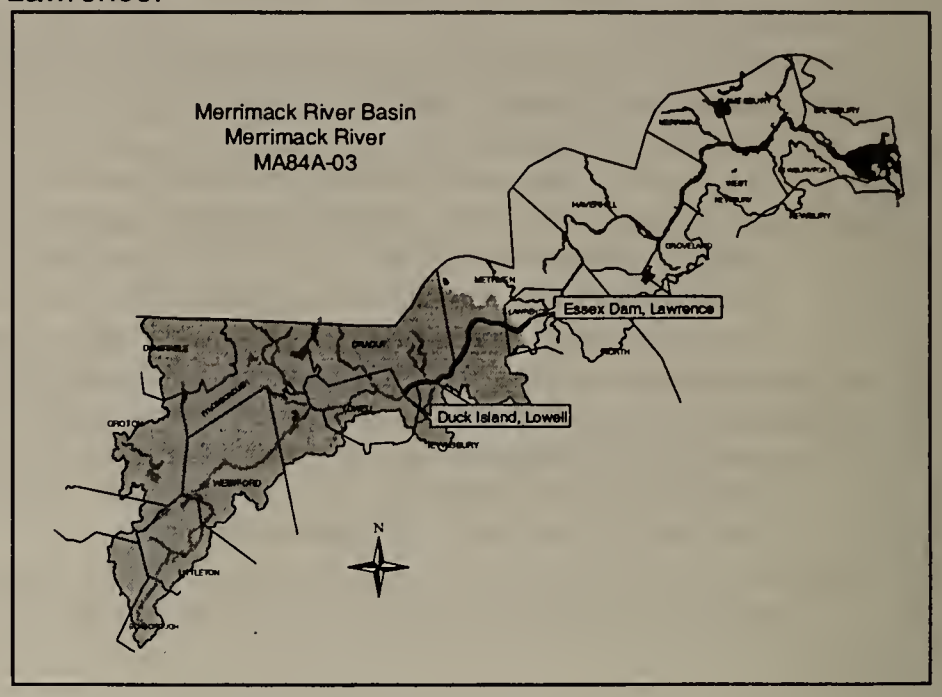
RECOMMENDATIONS: BEAVER BROOK (SEGMENT MA84A-11)

- As part of the WMA 5-year review, DEP should continue to evaluate Dracut Water District's compliance with their WMA registration.
- Evaluate potential of impacts from I-93 expansion.
- Monitor the effects of increased water withdrawals associated with development in the Beaver Brook subwatershed. Develop a hydrological assessment (inflow/outflow analysis) for this subwatershed.
- Evaluate the Draft and Final Long-Term CSO Control Plans for LRWWU and, when approved, require the LRWWU to implement CSO controls expeditiously to address these known sources of pollution.
- Collect water quality data, including bacteria data, to evaluate the effectiveness of LRWWU CSO abatement projects and sewering in Dracut.
- Continue to review water quality data (including any data from the ACOE project) to identify hotspots and integrate CSO and stormwater management activities to maximize water quality benefits.

- A habitat quality evaluation of Beaver Brook should be conducted and particular attention should be made to identify areas of sedimentation/erosion. Develop and implement BMPs to control storm water runoff.
- Instream biological (benthic macroinvertebrate and fish) monitoring should be conducted to evaluate changes in water quality conditions resulting from infrastructure improvements.
- As provided in Appendix C:
  - A site visit to the construction/excavating company adjacent to the BB01 reach is recommended to determine the extent that the property is a source (though other upstream sources no doubt exist) of sediment and trash inputs to this portion of the river. In addition, the Merrimack River Watershed Team may wish to contact either the Dracut Board of Health or the DEP Northeast Regional Office to determine if efforts have since been made to remedy the situation.
  - A site visit to the sand and gravel operation located upstream near the Long Pond Park portion of Dracut may be warranted as well. Improvements to the riparian zone along the east bank of the reach would be beneficial in alleviating the effects of nonpoint source inputs. Streambank stabilization and restoration of a riparian buffer may help to reduce the effects of road and parking lot runoff in this portion of Beaver Brook.

MERRIMACK RIVER (SEGMENT MA84A- 03)

Location: Duck Island, Lowell to Essex Dam, Lawrence.
Size: 8.8 miles.
Classification: Class B, Warm Water Fishery, Treated Water Supply, CSO.



Land-use estimates (top three) for the Massachusetts portion of this subwatershed less the South Branch Souhegan River area (map inset, gray shaded area):

Forest	42%
Residential	30%
Open Land	8%

This segment is on the 1998 303(d) list of impaired waters for pathogens and nutrients (Table 3).

This segment of the river has a significant amount of public use (Greater Lawrence summer boating program) (Goodno 2001).

Nickel Hill Energy, LLC. has proposed to build a 750 megawatt natural gas-fired combined-cycled power plant along the Merrimack River on the Dracut/Methuen town line. The facility has been approved and is the process of obtaining necessary permits. The proposed water withdrawal will be a significant consumptive loss (Goodno 2001).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Andover Water Treatment [a]	3009000	9P31300901	31300901	009-02S [b]	4.56 reg[b] 3.95 per[b] 8.51 total[b]	4.80[b]
Methuen Water Department	3181000	[c] (see note below)	31318101	01S Merrimack River	4.59	5.02 [c]
Tewksbury Water Department	3295000	9P31329501		295-01S Merrimack River Treatment Plant	3.17	2.5
Lawrence Water Works	3149000		31314902	149-01S (Merrimack River)	9.46	7.11
Hickory Hills Golf Course, Inc.[e]			31318102	River Intake Well #1	0.07 (153 days)	0.15 [d]

[a] withdrawal is pumped to Haggetts Pond (01S) before distribution (approximately half of supply),
[b] indicates system-wide withdrawal; all sources are not necessarily within this segment,
[c] Methuen exceedance is enforcement sensitive, they submitted a permit application several years ago but DEP has issues to resolve and has not yet approved the permit (O'keefe 2001),
[d] withdrawal did not exceed registration amount by more than 0.1 MGD (WMA threshold),
[e] withdrawal in small tributary to this Merrimack segment

It should also be noted that the Lawrence Water Works is in the process for designing a new water treatment plant (upgrading their leak detection capability and calibrating their meters).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLES D1 AND D2):

Lowell Regional Wastewater Utility is permitted (MA0100633 to discharge (permit issued August 1997) 32 MGD of treated municipal and industrial wastewater via outfall) 035 to the Merrimack River. The facility is capable of providing secondary treatment to combined wastewater and storm water flows up to 64 MGD and for primary treatment and disinfection for combined flows up to 112 MGD. During heavy precipitation

events, the facility discharges via one or more of their nine CSOs (also known as storm water diversion structures). The facility's whole effluent toxicity limit (permit requires testing with *Ceriodaphnia dubia* and *Pimephalas promelas*) is $LC_{50} \geq 100\%$ effluent. Their TRC limit is 0.22 mg/L (monthly average) and 0.38 mg/L (maximum daily). TRC in the effluent (data maintained in the TOXTD database) ranged from BDL to 0.78 mg/L and exceeded 0.38 in three of the nine measurements.

Tewksbury Water Treatment Plant (WTP) is permitted (MAG640036) to discharge (permit coverage effective June 1996) to this segment of the Merrimack River. (Their individual permit MA0102954 was terminated after the general permit was issued).

USE ASSESSMENT:

AQUATIC LIFE

Toxicity

Effluent

Lowell Regional Wastewater Utility conducted two acute and seven modified acute and chronic toxicity tests on their effluent using *C. dubia* between February 1996 and February 1998 on their treated effluent (Outfall 035) discharge. Whole effluent LC_{50}'s were all >100% effluent. The CNOEC results ranged between 25 and 100% effluent.

Chemistry – tissue (whole fish)

Three species of fish collected (summer/fall 1998) by the USFWS from this segment of the Merrimack River (Reach #5 located in the vicinity of Kenwood, Dract/Tewksbury) were submitted to the USEPA Lexington Laboratory for analysis (McDonald 1999). Two four-fish composite whole fish samples of smallmouth bass, one four-fish composite whole fish sample of largemouth bass and four five-fish whole fish composite samples of white sucker were analyzed for total mercury, lead and cadmium, organochlorine pesticides and total PCB (McDonald 1999). Cadmium and lead concentrations were below detection in all samples analyzed. The mercury concentrations in the whole fish samples ranged between 0.16 to 0.74 mg/Kg wet weight. The concentrations of organochlorine pesticides were all below the NAS/NAE guidelines for the protection of fish-eating wildlife. The concentrations of total PCB in the whole fish samples analyzed (data ranged from 2.91 to 7.76 mg/Kg wet weight), however, exceeded the NAS/NAE guidelines of 0.5 mg/Kg wet weight.

Due to the elevated concentration of PCB in whole fish collected from this segment of the Merrimack River (six to 15 times the NAS/NAE guideline for the protection of fish-eating wildlife), the *Aquatic Life Use* is assessed as partial support. The effect(s), if any, of the multiple upstream discharges (NPDES permittees, power plants, and CSOs) and the Lowell Regional Wastewater Utility discharge on aquatic life in this segment of the Merrimack River are currently unknown.

FISH CONSUMPTION

In September 1994 fish toxics monitoring was conducted by DWM in this segment of the Merrimack River. These data can be found in Appendix B, Table B8. Based on these data, the DPH issued a fish consumption advisory due to mercury contamination for the Merrimack River - all towns between Tyngsborough and Methuen, as follows (MDPH 2001a):

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat white sucker or largemouth bass from this waterbody."
2. "The general public should limit consumption of white sucker and largemouth bass to two meals per month."

1. The Merrimack River flows through two areas of Methuen located both upstream and downstream of the Essex Dam in Lawrence.

Because of the site-specific MDPH fish consumption advisory, which encompasses this segment of the Merrimack River, the *Fish Consumption Use* is assessed as non-support due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

PRIMARY CONTACT* AND *SECONDARY CONTACT RECREATION

While there are no CSOs that discharge directly into this segment of the Merrimack River, this segment is downstream from the Lowell Regional Water and Wastewater Utilities treated effluent discharge and their nine CSOs. As described in Segment MA84A-02, an estimated 352 MG of CSO is discharged up to 37 times per year from Lowell's nine CSO Diversion Structures (Brander 2001).

Fecal coliform bacteria samples were collected from three stations in this segment of the Merrimack River by DEP as part of the Microbial Indicator Study of the Merrimack River; just downstream of the LRWWU discharge, at the Methuen Water Treatment Plant Merrimack River Intake and at the Lawrence Water Treatment Plant Merrimack River Intake (Appendix G). Of the 13 samples collected at these three stations between August 1999 and April 2001 the highest count was 420 cfu/100mLs (Appendix G, Table G1). Only one count exceeded 400 cfu/100 mls.

It should also be noted that sewering in Dracut has reduced pollutants from entering this segment of the Merrimack River. Approximately 20-25 homes have been tied into the LRWWU (Casella 2001).

While the bacteria data indicated generally good water quality conditions that would support *Primary* and *Secondary Contact Recreational* uses, it is best professional judgement that the data set is considered too limited to assess these uses. The bacteria data do not provide enough spatial/temporal coverage to capture any effect(s) of the multiple LRWWU CSO discharges that frequently occur upstream. Although the status of the *Recreational Uses* is not assessed, these uses are identified with an "Alert Status". Sources of bacteria include the CSO discharges in Lowell and other upstream communities as well as urban runoff. It should be noted, however, that LRWWU is currently implementing "nine minimum controls" and planning for additional CSO pollution abatement strategies.

AESTHETICS

The MRWC reports that this segment of the Merrimack River is generally aesthetically pleasing (Goodno 2001). This use is however identified with an "Alert Status" because of the CSO discharges.

The *Aesthetics Use* is assessed as support.

Merrimack River (MA84A-03) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	PCB		Unknown	
Fish Consumption		NON SUPPORT	Mercury		Unknown	Atmospheric Deposition
Primary Contact*		NOT ASSESSED				
Secondary Contact*		NOT ASSESSED				
Aesthetics*		SUPPORT				

* "alert status" issues identified, details in this segment's USE ASSESSMENT section

RECOMMENDATIONS: MERRIMACK RIVER (SEGMENT MA84A-03)

- Conduct additional monitoring (e.g., passive water column PCB samplers, whole fish tissue), to determine the extent, and if necessary, source(s) of PCB contamination.
- Conduct biological monitoring (e.g., benthic macroinvertebrates, fish population) to evaluate the effect(s), if any, of the multiple upstream discharges (NPDES permittees, power plants, and CSOs) and the Lowell Regional Wastewater Utility discharge on aquatic life in this segment of the Merrimack River.
- Collect water quality data, including bacteria data, to evaluate the effectiveness of CSO abatement projects.

- Continue to review water quality data (including any data from the ACOE project) to identify hotspots and integrate CSO and stormwater management activities to maximize water quality benefits.
- Continue to evaluate Andover Water Treatment compliance with WMA registration and/or permit limits.
- As part of the WMA 5-year review, DEP should continue to evaluate Tewksbury Water Treatment compliance with their WMA permit limit, Lawrence Water Work's compliance with their WMA registration and continue to carefully monitor Hickory Hills Golf Course's compliance with WMA registration threshold.
- Resolve and issue Methuen Water Department's WMA permit with appropriate limits and monitoring requirments.

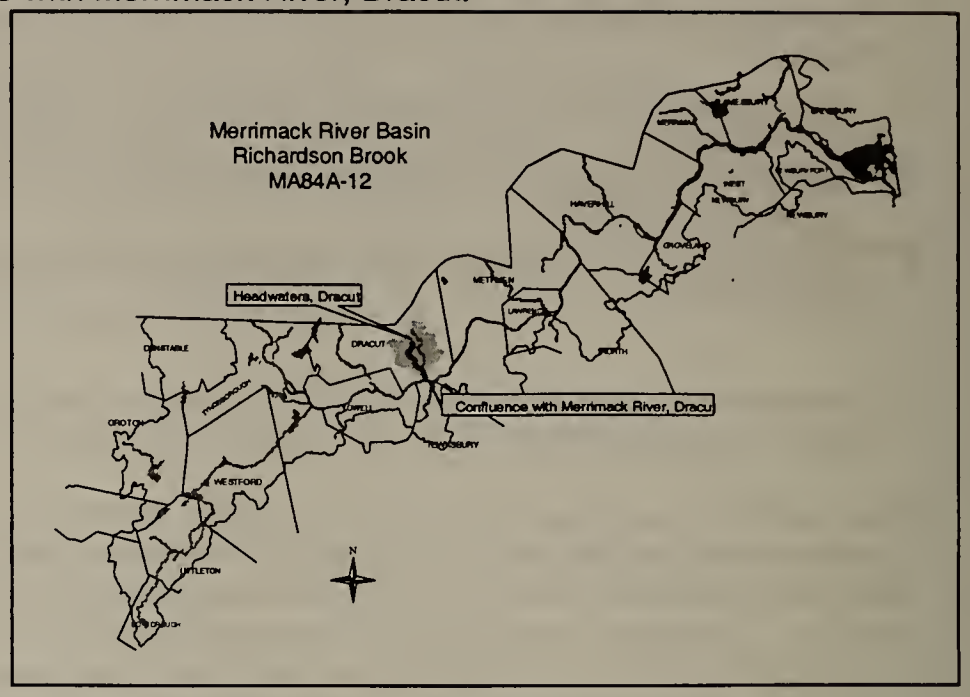
RICHARDSON BROOK (SEGMENT MA84A-12)

Location: Headwaters, Dracut to confluence with Merrimack River, Dracut.
Size: 3.4 miles.
Classification: Class B.

Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	44%
Residential	23%
Agriculture	17%

This segment is on the 1998 303(d) list of impaired waters, needing confirmation, for other habitat alterations and noxious aquatic plants (Table 3).



WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
P.J. Keating Company			31307901	Merrimack Intake	0.58 (306)	0.16

NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information there are no regulated surface wastewater discharges in this subwatershed. It should be noted however that Dracut is a Phase II Stormwater community. Dracut must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:

The most recent benthic macroinvertebrate survey in Richardson Brook was conducted in June 1990. One station, RBR01 (upstream of the Methuen Street Bridge) was found to be moderate impacted (RBP II analysis) although causes and sources of impairment were not identified (Smith *et al.* 1990). No recent data has been collected, therefore all uses are not assessed.

Richardson Brook (MA84A-12) Use Summary Table

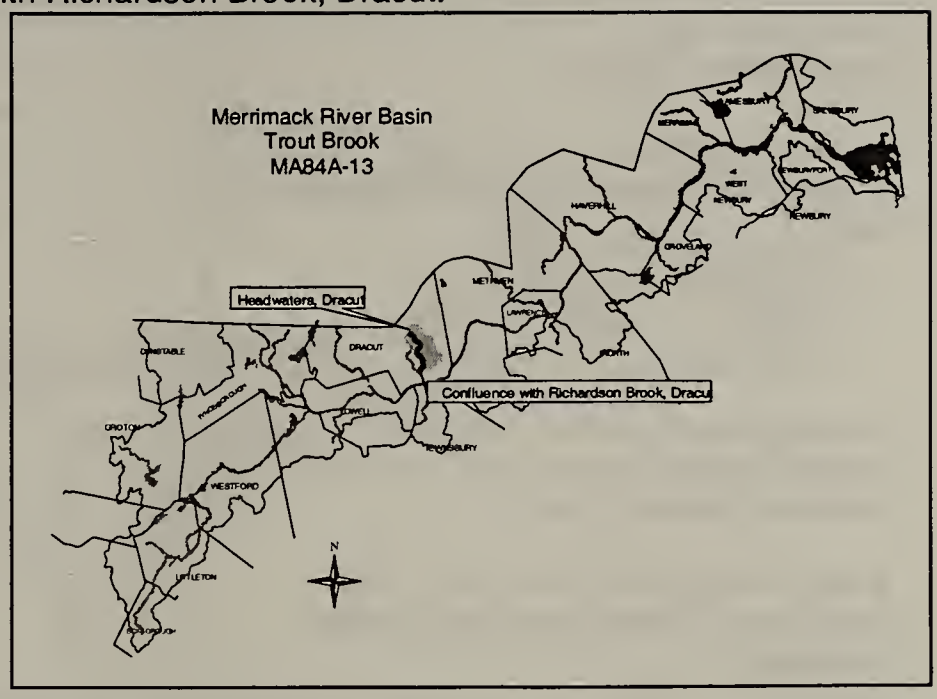
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: RICHARDSON BROOK (SEGMENT MA84A-12)

- Reevaluate the quality of habitat and the benthic macroinvertebrate community in Richardson Brook to document any changes in water quality conditions.
- As part of the WMA 5-year review, DEP should continue to evaluate PJ Keating Company's compliance with their WMA registration.
- Conduct water quality monitoring (bacteria sampling) to assess the effectiveness of sewering in Dracut.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

TROUT BROOK (SEGMENT MA84A-13)

Location: Headwater, Dracut to confluence with Richardson Brook, Dracut.
Size: 4.0 miles.
Classification: Class B.



Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	47%
Agriculture	20%
Open Land/Residential	14% each

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information there are no regulated water withdrawals or surface wastewater discharges in this subwatershed. The Exxon Company USA NPDES permit MA0022225 was inactivated in April 1991.

It should be noted, however, that Dracut is a Phase II Stormwater community. Dracut must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:

The most recent benthic macroinvertebrate survey in Trout Brook was conducted in June 1990. One station, TBR02 (at the Kenwood Street Bridge) was found to be non-impacted (RBP II analysis) (Smith *et al.* 1990). Native trout were also observed. No recent data has been collected, therefore all uses are not assessed.

Trout Brook (MA84A-13) Use Summary Table

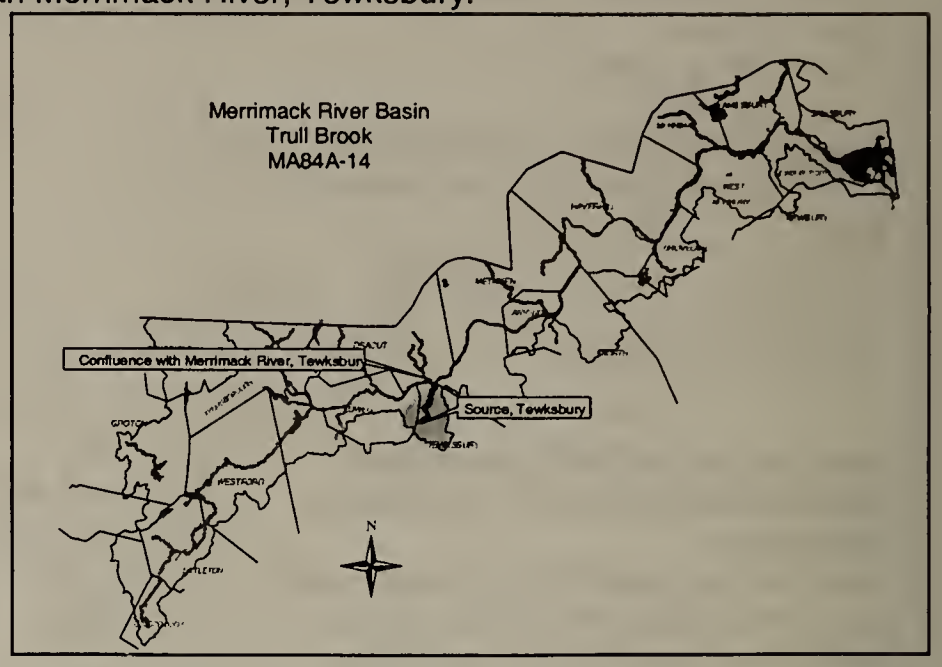
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: TROUT BROOK (SEGMENT MA84A-13)

- Conduct field reconnaissance to identify any areas that may be of concern in the Trout Brook Subwatershed.

TRULL BROOK (SEGMENT MA84A-14)

Location: SourceTewskbury to confluence with Merrimack River, Tewksbury.
Size: 3.25 miles.
Classification: Class B.



Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Residential	35%
Forest	30%
Open Land	12%

This segment is on the 1998 303(d) list of impaired waters, needing confirmation, for unknown toxicity (Table 3).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information there are no WMA regulated water withdrawals or surface wastewater discharges in this subwatershed. It should be noted however that Dracut is a Phase II Stormwater community. Dracut must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:

The most recent benthic macroinvertebrate survey in Trull Brook was conducted in July 1990. Two stations, TB02 (downstream of the River Road Bridge) and TB01 (near the 14th fairway of the Trull Brook golf course) were sampled by DEP (Smith *et al.* 1990). Both stations were found to be moderately impacted (RBP II analysis) although causes and sources of impairment were not identified. No recent data have been collected, therefore all uses are not assessed.

Trull Brook (MA84A-14) Use Summary Table

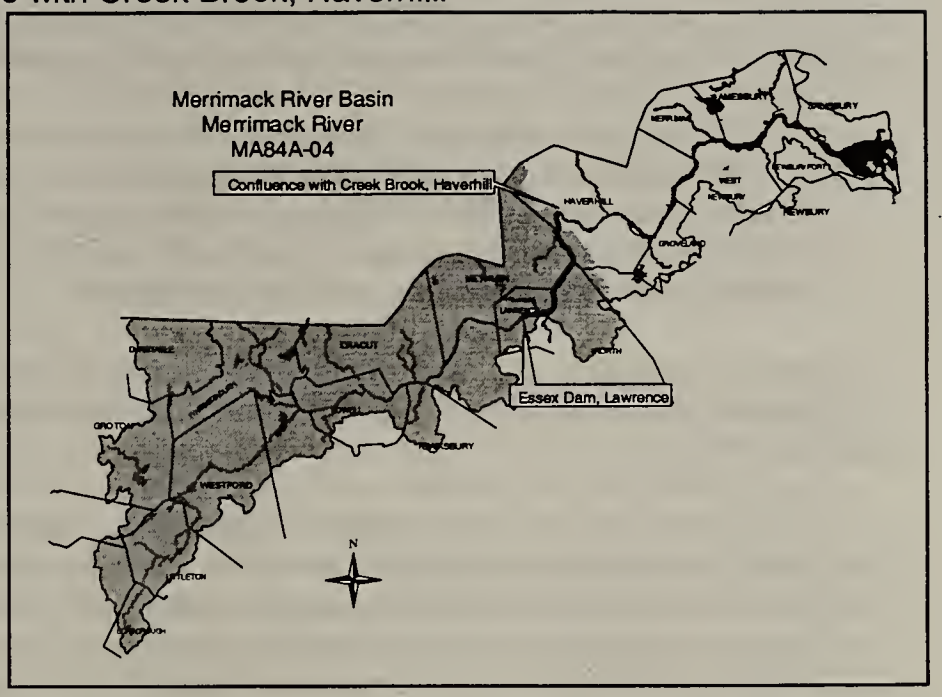
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: TRULL BROOK (SEGMENT MA84A-14)

- Reevaluate the quality of habitat and the benthic macroinvertebrate community in Trull Brook to document any changes in water quality conditions.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

MERRIMACK RIVER (SEGMENT MA84A-04)

Location: Essex Dam, Lawrence to confluence with Creek Brook, Haverhill.
Size: 7.1 miles.
Classification: Class B, Warm Water Fishery, CSO.



Land-use estimates for the Massachusetts portion of this subwatershed less the South Branch Souhegan River area (map inset, gray shaded area):

Forest	39%
Residential	32%
Open Land	8%

This segment is on the 1998 303(d) list of impaired waters for pathogens and nutrients (Table 3).

The Essex Dam in Lawrence, MA has two fish passages. There is a fish elevator (36 feet) used for upstream runs and a fish bypass used for downstream runs. The MA Division of Fisheries and Wildlife monitors and records fish passages through these structures (Nutter 2001). This segment of the Merrimack River is heavily utilized for fishing and boating (Goodno 2001).

The Merrimack River occasionally floods (back flows) into a few old mill buildings along the banks of the river (Goodno 2001). These occurrences are of concern to the Merrimack River Watershed Council although the effect(s), if any, on water quality are currently unknown. Recently, an EPA Task Force evaluated land-based use problems in the city of Lawrence (Goodno 2001).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Merrimack Paper Company, Inc.			31314903	Essex Co. South Canal Merrimack River	0.55	0.69*
Newark Atlantic Paperboard Corp.			31314901	North Canal Intake	0.56	0.32
Lucent Technologies, Inc.		9P31321001	31321002	Well # 1, 2, 3, 4, 5	0.38 reg 0.29 per 0.67 total	0.17
Spring Hill Farm Dairy, Inc.			31312805	River Intake	0.06	0.01

* withdrawal exceeded registration amount by more than 0.1 MGD (WMA threshold)

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLES D1 AND D2):

AEP Industries, North Andover is permitted (MA0035432) to discharge (permit issued September 1997) 0.08 MGD of contact and non-contact cooling water and storm water via outfall # 001 to this segment of the Merrimack River. The permit limit for whole effluent toxicity is $LC_{50} > 50\%$ using two test organisms, *C. dubia* and *P. promelas*. Other maximum daily permit limits include pH (6.5 to 8.3), temperature (83° F), and fecal coliform bacteria (< 400 cfu/100 mL).

The Greater Lawrence Sanitary District (GLSD) provides wastewater conveyance, treatment, and disposal for the communities of Lawrence, Methuen, Andover, North Andover, MA and Salem, NH. Of the communities in the District, only the City of Lawrence has a combined sewer system. GLSD is permitted (MA0100447) to discharge (permit issued February 1998) 52 MGD (average monthly) of treatment plant effluent via outfall # 001 to this segment of the Merrimack River. The permit limits for

whole effluent toxicity are $LC_{50} \geq 100\%$ and CNOEC (report only) using *C. dubia*. The facility's TRC limit is 0.15 mg/L. (average monthly) and 0.26 mg/L (maximum daily). TRC in the effluent (data maintained in the TOXTD database) were all BDL. GLSD also permitted to discharge via four CSO outfalls along this segment of the Merrimack River and one outfall to the Spicket River as indicated below:

CSO 003 – South Bank interceptor downstream from the Essex Dam/O'Leary Bridge
CSO 005 – North Bank interceptor downstream from Casey Bridge
CSO 002 – South Bank interceptor downstream from Duck Bridge
CSO 004 – North Bank interceptor at the mouth of the Spicket River
CSO 006 - The New Spicket River Interceptor

Ferrous Technologies, Inc., Lawrence is permitted (MAG250015) to discharge (permit effective February 1998) 0.015 MGD (maximum daily) of non-contact cooling water to the canal along this segment of the Merrimack River.

Lucent Technologies, Inc. is permitted (MA0001261-- transferred from American Telephone and Telegraph Company) to discharge (permit issued March 1992) via the following outfalls (maximum daily):

001A - 1.3 MGD of treated wastewater from electroplating (metal finishing) manufacturing,
001B - 0.3 MGD of treated sanitary wastewater,
001C - 0.11 MGD of non-contact cooling water, ultrasonic cleaning water and well water used for backwash,
001D - 0.4 MGD of deionized water, and
001E – 360 gallons per minute of treated (remediation) ground water from wells of the property.

[Note: the toxicity testing limit $LC_{50} \geq 50\%$ effluent is required on the combined 001 discharge.]

Outfall #002 - 0.055 MGD of non-contact cooling water and blowdown from the process water system, and
Outfall #002 - two dumps per year of discharged at a rate of 100gpm for 2 – 5 days (routine maintenance) of 0.05 MG per year maximum of non-contact cooling water from the chilled water system.

Newark Atlantic Paperboard Corp., Lawrence is permitted (MAG250813) to discharge (permit effective June 2001) 0.215 MGD (monthly average) and 0.5 MGD (maximum daily) of non-contact cooling water canal to this segment of the Merrimack River.

Boott Hydropower, Lawrence Hydroelectric is permitted (MAG250948) to discharge (permit effective September 2000) 0.9 MGD of non-contact cooling water to this segment of the Merrimack River.

Vernon Plastics Corporation is permitted (MA0002984) to discharge (permit issued March 1985) 0.0012 MGD (maximum daily) of non-contact cooling water via outfall #001, 0.0084 MGD of contact cooling water and storm water runoff via outfall #002, and storm water runoff via outfall #003 (after cooling water tie-in to Haverhill WWTP) to an unnamed tributary to this segment of the Merrimack River. The facility has a current general stormwater permit (MAR05C145). According to a letter from the company to EPA, all discharges from outfalls #001 and 002 were eliminated in 1985 (Dumas 2001).

Sweetheart Cup Company, Inc. is permitted (MAG250012) to discharge (permit coverage effective April 2001) 0.015 MGD (average monthly) of non-contact cooling water to a tributary of this segment (not named in permit) of the Merrimack River.

OTHER:

FERC:

The Lawrence Project Number 2800 owned by the Lawrence Hydro Assoc. is located at the southern point of the Essex Dam on the Merrimack River. The project generates 16800 Kilowatts. The FERC license was issued December 1978 and expires November 2028 (Kaye 2001a). The Essex Dam was built in 1848, is 39' in height and is 943 feet in length. The project operates as a run-of-river facility and has fish passage facilities (Enrico 2000b). The project has one powerhouse, two generators and two turbines (Kaye 2001a). The project releases a minimum flow of 951 cfs either through the powerhouse or over the dam in the event of a plant shutdown (Enrico 2000b).

The Aquamac Project Number 2927 owned by the Aquamac Corp. is located on the South Canal (along this segment of the Merrimack River). The project has the capacity to generate 250 Kilowatts. The FERC license was issued October 1979 and expired September 1999 (Kaye 1998a). An application for the new license was accepted for filing in October 1997. An Environmental Assessment (EA) was conducted for this and the Merrimack Project 2928 relating to the Comprehensive Fish Passage Plan (CFPP) for the Merrimack River (FERC 2001a). The project has one generating unit. The project does not include any dam; it draws water from the reservoir created by the Essex Dam and the intake is located in the South Canal (Kaye 1998a). The CFPP now requires the annual closure of the South Canal between April 22 and July 15 and between September 1 and November 15 to project migratory fishes in the Merrimack River (FERC 2001b). Downstream passage of fish into the South Canal is accomplished by closing the canal during the migratory season (Enrico 2000b).

The Merrimack Project Number 2928 owned by the Merrimack Paper Co. Inc. is located on the South Canal (along this segment of the Merrimack River). The project generates 1088 Kilowatts. The FERC license was issued December 1979 and expired November 1999 (Kaye 1998b). An application for the new license was accepted for filing in October 1997. This project is adjacent to the Aquamac Project. Like the Aquamac Project, an Environmental Assessment (EA) was conducted relating to the CFPP for the Merrimack River (FERC 2001a). The project has one generating unit and does not include any dam. It draws water from the reservoir created by the Essex Dam and the intake is located in the South Canal (Kaye 1998b). The CFPP now requires the annual closure of the South Canal between April 22 and July 15 and between September 1 and November 15 to project migratory fishes in the Merrimack River (FERC 2001b). Downstream passage of fish into the South Canal is accomplished by closing the canal during the migratory season (Enrico 2000b).

USE ASSESSMENT:

AQUATIC LIFE

Habitat and Streamflow

Based on the available information there is essential no by-pass reach below the Essex Dam (the tailrace flows into the Merrimack at the base of the dam).

Biology

Anadromous fish counts for the Merrimack River at the Essex Dam in Lawrence in 2001 are as follows (USFWS 2001e):

Altantic Salmon: 78

American Shad: 74,660

River Herrings (both blueback herring and alewife): 1,550

Toxicity

Ambient

Greater Lawrence Sanitary District (GLSD) collects Merrimack River water (upstream of their discharge at the Route 495 bridge) for use as dilution water in their whole effluent toxicity tests. Between February 1996 and February 2001, survival of *C. dubia* exposed (7-day) to the river water was good ($\geq$ 80%).

Lucent Technologies, Inc. collects Merrimack River water (50 yards upstream of their discharge which is located downstream of the GLSD discharge) for use as dilution water in their whole effluent toxicity tests. Between February 1996 and July 2000, survival of both *C. dubia* and *P. promelas* exposed (48-hour) to the river water was good ($\geq$ 90%).

Effluent

GLSD conducted 22 modified acute and chronic toxicity tests using *C. dubia* between February 1996 and February 2001 on their treated effluent (Outfall # 001). The LC_{50}'s were >100% effluent with the exception of the November 1998 test (LC_{50} = 89.1%). The CNOEC results ranged between 12.5 and 100% effluent.

Lucent Technologies, Inc. conducted 11 acute toxicity tests using both *C. dubia* and *P. promelas* between February 1996 and July 2000 on their treated effluent (Outfall # 001). The LC_{50}'s ranged from 85 to 100% effluent. *C. dubia* has consistently been the more sensitive test organism.

Chemistry – water

GLSD collects Merrimack River water (upstream of their discharge at the Route 495 bridge in Lawrence) for use as dilution water in their whole effluent toxicity tests. Between February 1996 and February 2001 a total of 22 reports were submitted. Data from these reports are summarized below.

Lucent Technologies, Inc. collects Merrimack River water (50 yards upstream of their discharge located downstream of the GLSD discharge) for use as dilution water in their whole effluent toxicity tests. Between February 1996 and July 2000, a total of 11 reports were submitted. Data from these reports are summarized below.

pH

Both GLSD and Lucent Technologies, Inc. data ranged from 6.6 to 7.8 SU.

Suspended Solids

GLSD data did not exceed 12 mg/L and the Lucent Technologies, Inc. data ranged between BDL and 26 mg/L (only one exceeded 25 mg/L).

Ammonia-Nitrogen

GLSD data ranged from BDL to 0.98 mg/L and the Lucent Technologies, Inc. data ranged from BDL to 1.0 mg/L.

Total Residual Chlorine

Both the GLSD and the Lucent Technologies, Inc. data were all BDL.

Chemistry – tissue (whole fish)

White sucker were collected (summer/fall 1998) by the USFWS from the lower end of this segment of the Merrimack River (Reach #3 located in the vicinity of Kimball Island, Methuen/Haverhill). These samples, three five-fish composite and one six-fish composite, were submitted to the USEPA Lexington Laboratory for analysis (McDonald 1999). These whole fish composite samples were analyzed for total mercury, lead and cadmium, organochlorine pesticides and total PCB (McDonald 1999). Cadmium and lead concentrations were below detection in all samples analyzed. The mercury concentrations in the whole fish samples ranged between 0.16 to 0.25 mg/Kg wet weight. The concentrations of organochlorine pesticides were all below the NAS/NAE guidelines for the protection of fish-eating wildlife. The concentrations of total PCB in the whole fish samples analyzed ranged from 0.22 to 8.6 mg/Kg wet weight. Three of the four samples analyzed exceeded the NAS/NAE guidelines of 0.5 mg/Kg wet weight.

Due to the elevated concentration of PCB in whole fish collected from this segment of the Merrimack River (less than one to 17 times the NAS/NAE guideline for the protection of fish-eating wildlife) the *Aquatic Life Use* is assessed as partial support. The effect(s), if any, of the multiple discharges (NPDES permittees, power plants, and CSOs) within this segment as well as upstream on aquatic life are currently unknown although the limited whole effluent and ambient toxicity testing data indicated good water quality conditions.

FISH CONSUMPTION

In September 1994 fish toxics monitoring was conducted by DWM in this segment of the Merrimack River. These data can be found in Appendix B, Table B8. Based on these data, the DPH issued a fish consumption advisory due to mercury contamination for the Merrimack River - all towns between Tyngsborough and Methuen, as follows (MDPH 2001a):

1. "Children younger than 12 years, pregnant women, and nursing mothers should not eat white sucker or largemouth bass from this waterbody."
2. "The general public should limit consumption of white sucker and largemouth bass to two meals per month."

The Merrimack River flows through two areas of Methuen located both upstream and downstream of the Essex Dam in Lawrence. The mercury concentrations in fillets of fish collected from the river downtstream of the Essex Dam in Lawrence were below the DPH action levels and after discussion with DPH, the advisory will be clarified to read the Essex Dam (Beattie 2001).

The *Fish Consumption Use* is not assessed for this segment of the Merrimack River. It should be noted that a statewide fish consumption advisory is in effect (see Fish Consumption Use assessment guidance, page 7).

PRIMARY* AND *SECONDARY CONTACT RECREATION

While the GLSD is implementing CSO pollution abatement strategies their five CSO outfalls presently activate up to 14 times annually and result in the discharge of approximately 111 million gallons of CSO during a year with typical precipitation. The April 2001 GLSD Interim CSO Report indicates that CSO 004 is the most active CSO, activating approximately 14 times with an estimated annual volume of 76 million gallons, or about 68% of the total CSO volume (CDM 2001b).

The *Primary and Secondary Contact Recreational* uses are currently not assessed for this segment of the Merrimack River, however they are identified as being on "Alert Status" because of the GLSD (and other upstream) CSO discharges.

AESTHETICS

The Merrimack River Watershed Council reports that this segment of the Merrimack River is generally aesthetically pleasing (Goodno 2001).

The *Aesthetics Use* is assessed as support.

Merrimack River (MA 84A-04) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	PCB		Unknown	
Fish Consumption		NOT ASSESSED				
Primary Contact*		NOT ASSESSED				
Secondary Contact*		NOT ASSESSED				
Aesthetics		SUPPORT				

* "alert status" issues identified, details in this segment's USE ASSESSMENT section

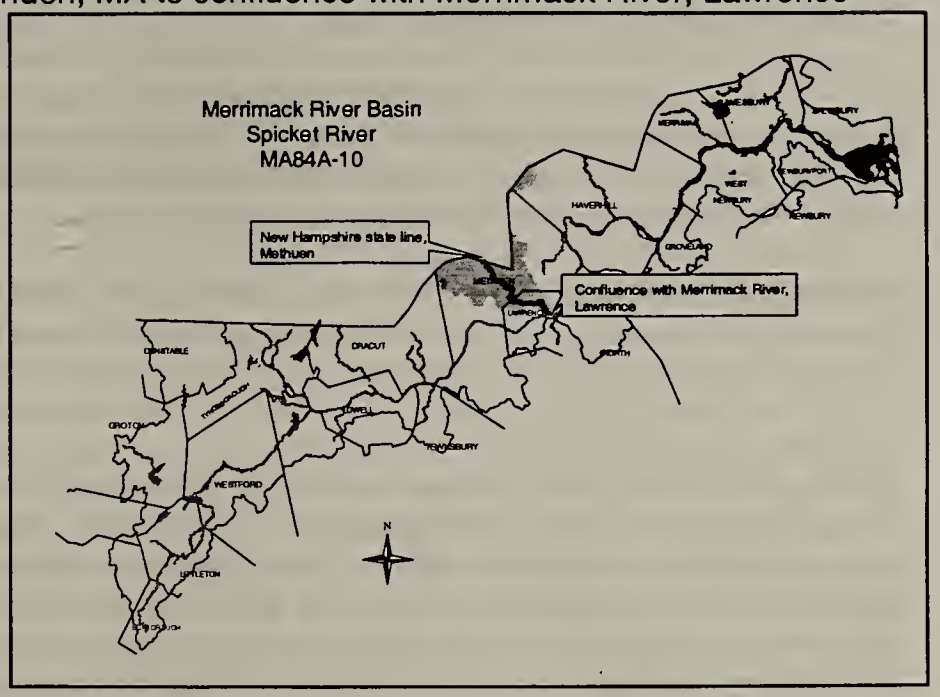
RECOMMENDATIONS: MERRIMACK RIVER (SEGMENT MA84A-04)

- Conduct additional monitoring (e.g., passive water column PCB samplers, whole fish tissue), to determine the extent, and if necessary, source(s) of PCB contamination.
- Conduct biological monitoring (e.g., benthic macroinvertebrates, fish population) to evaluate the effect(s), if any, of the multiple upstream discharges (NPDES permittees, power plants, and CSOs) and the GLSD discharge on aquatic life in this segment of the Merrimack River.
- Evaluate the potential for contamination to the Merrimack River from the old mill buildings that are occasionally flooded.
- Evaluate the Draft and Final Long-Term CSO Control Plans for GLSD, and, when approved, require GLSD to implement CSO controls expeditiously to address these known sources of pollution.
- Collect water quality data, including bacteria data, to evaluate the effectiveness of GLSD and other upstream CSO abatement projects.
- Continue to review water quality data (including any data from the ACOE project) to identify hotspots and integrate CSO and stormwater management activities to maximize water quality benefits.

- As part of the WMA 5-year review, DEP should continue to evaluate Newark Atlantic Paperboard Corp. and Spring Hill Farm Dairy, Inc. compliance with their WMA registrations.
- As part of the WMA 5-year review, DEP should continue to evaluate Lucent Technologies, Inc. compliance with their WMA registration and/or permit limit.
- As part of the WMA 5-year review, DEP should follow up on the Merrimack Paper Company, Inc.'s WMA exceedance of registration threshold and take appropriate actions as deemed necessary.
- Obtain and evaluate the results of AEP Industries, North Andover whole effluent toxicity tests. Develop and reissue their permit (MA0035432).
- Ferrous Technologies, Inc., Lawrence (MAG250015) should reapply for their NPDES permit.
- Develop and reissue Lucent Technologies, Inc. permit (MA0001261)(unless the company installs a closed loop system). The toxicity testing requirements could be reduced to *C. dubia* only since it has consistently been the more sensitive test organism.
- Vernon Plastics Corporation NPDES permit (MA0002984), which is still on EPAs "active permit list", should be terminated based on the information provided by the company.

SPICKET RIVER (SEGMENT MA84A-10)

Location: From the state line Salem, NH/ Methuen, MA to confluence with Merrimack River, Lawrence
Size: 6.4 miles.
Classification: Class B, Warm Water Fishery.



Land-use estimates (top three) for the Masachusetts portion of this subwatershed (map inset, gray shaded area):

Residential	41%
Forest	24%
Wetlands	8%

[Note: The Spicket River has a very large drainage area in NH that is not reflected in these land-use estimates.]

This segment is on the 1998 303(d) list of impaired waters for pathogens, nutrients, and metals (Table 3).

An Interstate Task Force, the Spicket River Flood Hazard Mitigation Committee, was formed in 1998 to identify and resolve flooding hazards along the Spicket River in both New Hampshire and Massachusetts. Snowmelt, heavy rainfall events from tropical storms, and backwater effects from constriction points (near the MA/NH border at I-93, Hampshire Road and a railroad bridge in Methuen and Daisy Street Bridge in Lawrence) have been identified as the principle flood problems that occur in the urbanized areas of Methuen and Lawrence MA and Salem NH. Among other accomplishments, the committee has succeeded in obtaining funding for a continuous-monitoring streamflow gaging station (installed by USGS on the NH/MA state line in October 2000) that was also established as a National Weather Service forecasting site to improve flood-forecasting capabilities on the Spicket River (Nelson 2001).

96-05/319 *Spicket River Watershed Revitalization*. The project utilized innovative technology demonstration, water quality monitoring and community-based education, outreach and remediation efforts to improve conditions in and adjacent to the Spicket River in Methuen and Lawrence between 1996 and 1998 (MRWC 1999). The innovative technology demonstration assessed the effectiveness of catchbasin filters and filter media in removing sediment, petroleum hydrocarbons and metals from stormwater. The results from this study were inconclusive.

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Malden Mills Industries, Inc.		9P31314901		Stevens Pond	3.33	0.74

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLES D1 AND D2):

ITT Semiconductor, Lawrence (MA0028347) applied for an NPDES permit in August 1983. According to EPA, the facility discontinued their operations in 1985 (Davis 2001).

Odgen Martin Systems, Lawrence (MA0031984) bought Refuse Fuel Associates, a waste for fuel, stream electric generation power plant, in the fall of 1987. Refuse Fuel Associates was authorized to discharge (MA0027626) 16 MGD from outfall serial # 001 circulating condenser cooling water to Stevens Pond. The permit limit temperature was 83 F and TRC was 0.1 mg/l (maximum daily). The company also discharged from outfall # 010 (demineralization wastewater), outfall #011 (cemetary runoff) and outfall #012 (yard drains and cemetery runoff) to the Spicket River. Ogden Martin closed their facility in 1998 and moved to Haverhill where their wastewater is tied into the sewer system (MA DEP 2001b).

Greater Lawrence Sanitary District (GLSD) is permitted (MA0100447) to discharge (permit issued February 1998) storm water/wastewater from combined sewer overflow (CSO) via outfall #006 (Spicket River Interceptor) to the Spicket River.

Gencorp, Inc., Lawrence is permitted (MA0003824) to discharge (permit issued July 1992) site water from their property to the Spicket River. The site (a hazardous waste site - RTN # 3-0000340) is being decommissioned. GenCorp Lawrence Location is in the process of decommissioning and remediating a former manufacturing facility located in Lawrence, MA.

It should also be noted that both Methuen and Lawrence are Phase II Stormwater communities. These communities must apply for permit coverage for their municipal drainage systems and are required to develop, implement and enforce their storm water management programs by March 2003 (Domizio 2001).

OTHER:
The Methuen Falls FERC Project Number 8093 owned by the Methuen Falls Hydro Elec Co. is located on the Spicket River. The project generates 357 Kilowatts. The FERC license was issued March 1986 and expires February 2026 (Kaye 2001b). The project is located at the Methuen Falls Dam, which was built in 1895 and is 23' in height and 188 feet in length. The project has one powerhouse and two generating units. The minimum flow release requirement is either 3 cfs or inflow, which is released over the dam or through the numerous leaks through the dam and flashboards (Kaye 2001b). There are no fish passage facilities.

USE ASSESSMENT:
AQUATIC LIFE

Biology

Throughout the course of the GenCorp, Inc. Lawrence remediation process, various environmental monitoring programs have been implemented to ensure that any inadvertent releases of materials to the environment would be detected. Personnel from the Aquatic Resource Center (ARC) in Franklin, TN have conducted six benthic macroinvertebrate surveys at four sites in the Spicket River in accordance with EPA's RBP methods between May 1995 and October 1997 to examine potential changes to the benthic community from their exposed raceway which discharges into the Spicket River (ARC 1998). ARC also conducted sampling in the GenCorp raceway discharge, Lawrence (Site 2). Their sampling stations in the Spicket River (upstream to downstream) are described below.

Site 5: between Union Street and Route 28 bridge, Methuen (above the City of Lawrence).
Site 4: upstream of the General Street Bridge, Lawrence (upstream from the GenCorp raceway)
Site 3: approximately 30 meters upstream from the GenCorp raceway, Lawrence.
Site 2: no information was provided for this site in the ARC reports.
Site 1: downstream from the GenCorp raceway discharge, approximately 150 meters upstream from the confluence with the Merrimack River, Lawrence.

Results of the ARC surveys conducted in the Spicket River upstream of the city of Lawrence (Site 5) found the river to be "slightly impaired" during their fall surveys conducted between 1995 and 1997 (ARC 1998). Metric values, however, especially taxa richness, Ephemeroptera, Plecoptera, and Trichoptera (EPT) richness, and Hilsenhoff Biotic Index (HBI) at this site were considerably better than those at the downstream stations. The benthic community (fall surveys) in the Spicket River in the vicinity of the GenCorp facility (Sites 1 – 4) was "slightly impaired" in 1997 which was an improvement over conditions found in 1995 (Sites 1- 4 were moderately impaired). The ARC evaluation of the 1997 data collected in the Spicket River found no impacts from the GenCorp discharge to the Spicket River (ARC 1998).

In July 1999 DWM also conducted an RBP III benthic macroinvertebrate survey in the Spicket River downstream from General Street in Lawrence (station SR01). The benthic macroinvertebrate data were found to be 84% comparable to the Fish Brook regional reference station (station FB00) in the Ipswich River Basin. Based on the RBP III analysis, the benthic community was non-impacted (Appendix C). These results indicate a dramatic improvement in the biological condition of the Spicket River since DWM's 1994 biosurvey. Improvements were thought to be related to improved CSO controls by GLSD and the elimination of the power plant discharge (Appendix C).

Habitat and Flow

Habitat quality in the Spicket River was described by ARC as being slightly to moderately affected upstream of the city of Lawrence (site 5) and moderately to severely affected downstream to the confluence with the Merrimack River (sites 1-4)(ARC 1998). During the DWM benthic macroinvertebrate survey in the Spicket River (station SR01), serious erosion was observed along the steep south bank in this highly industrialized and channelized area. Parking lots and numerous stormdrains entering the stream along the northern bank were also identified as potential non-point source pollution problems. Instream fish cover was lacking – the most stable cover was instream trash (metal, plastic, glass) (Appendix C). Flooding, known to occur along this segment of the Spicket River, may exascerbate erosion problems.

It is best professional judgement of DWM biologists that the ARC data collected in the upper reach of the Spicket River (Site 5) is indicative of a healthy benthic community relative to the Spicket River subwatershed and, therefore, the *Aquatic Life Use* is assessed as support for the upper 2.6 miles of this segment (NH state line to the most upstream Rt. 28 crossing). While DWM's RBP III analysis indicates "non-impairment" at SR01, this lower 3.8-mile reach of the Spicket River is affected by multiple discharges and urban runoff. That the SR01 benthic community remains dominated by fairly tolerant taxa (i.e., gammarid amphipods and chironomids) indicates that water quality problems related to organic enrichment still exist here (Appendix C). This is corroborated by ARC's findings (Sites 1-4) in which the benthos in the Spicket River were found to be slightly impacted. Based on DWM's benthos data at SR01, ARC's data at Sites1-4, and best professional judgement, the lower 3.8 miles of the Spicket River are assessed as partial support for the *Aquatic Life Use*. Known causes of impairment include habitat alteration/modification (removal of riparian zone/lack of vegetative buffer) and channelization as well as unknown water quality degradation likely the result of urban runoff.

PRIMARY* AND *SECONDARY CONTACT RECREATION

No recent fecal coliform bacteria data were available to assess the status of the recreational uses. While the GLSD is implementing CSO pollution abatement strategies; their five CSO outfalls presently activate up to 14 times annually, resulting in the discharge of approximately 111 million gallons of CSO during a year with typical precipitation. The April 2001 GLSD Interim CSO Report indicates that CSO 006 activates approximately five times with an estimated annual volume of 8.3 million gallons, or about 8% of the total CSO volume (CDM 2001b).

Because of the aesthetic quality degradation in the Spicket River observed by DWM field personnel and (see *Aesthetics Use* below), the *Primary* and *Secondary Contact Recreational* uses are assessed as non- support for the lower 3.8 miles of the Spicket River. The CSO discharge to the Spicket River is also of concern in this reach. The upper 2.6 miles are currently not assessed for the recreational uses.

AESTHETICS

DWM conducted a habitat assessment in 1999 in the lower reach of the Spicket River as part of the benthic macroinvertebrate survey (Appendix C). This portion of the river contained objectionable deposits of trash/debris (e.g., metal, plastic, glass). Slight turbidity was also noted. These conditions were considered to be problematic throughout the lower 3.8 mile reach (where the Spicket River flows through the city of Lawrence).

Shoreline surveys were also conducted along the Spicket River as part of the *Spicket River Watershed Revitalization Project* 96-05/319 (Appendix F). There were observations of isolated areas of trash in the upper portion of this segment in Methuen, however, the stream team volunteers described "astronomical amounts of debris and trashed that has been dumped into the river within Lawrence" (MRWC 1999).

Because of the substantial deposits of trash/debris, as well as slight turbidity, the lower 3.8-mile reach of the Spicket River does not support the *Aesthetics Use*. The upper 2.6-mile reach is assessed as support for this use.

Spicket River (MA84A-10) Use Summary Table

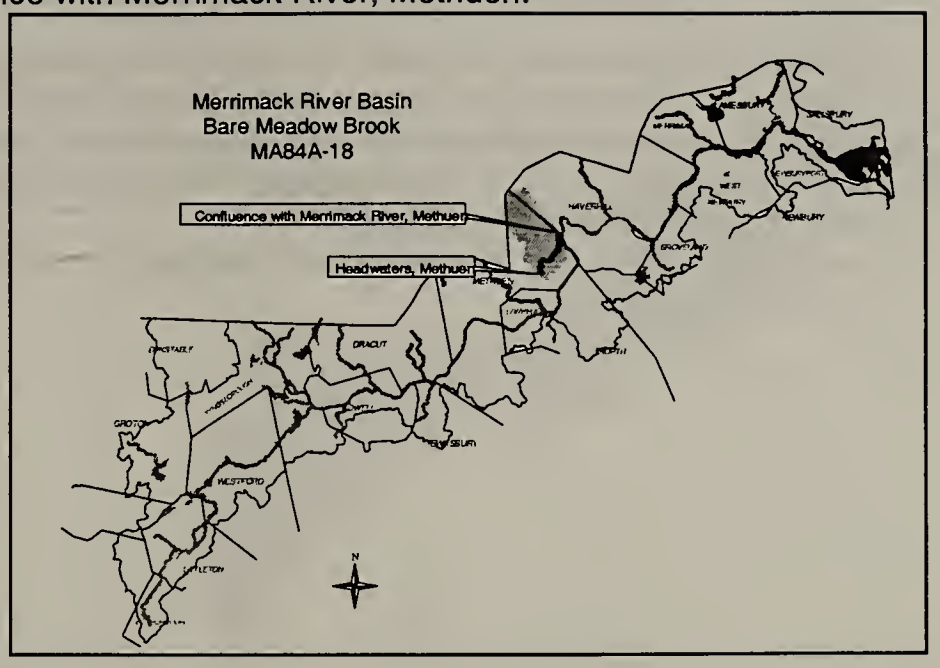
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		SUPPORT – upper 2.6 miles PARTIAL SUPPORT lower 3.8 miles	Habitat alteration, unknown	Organic enrichment	Municipal point sources, urban runoff/storm sewers, habitat modification (removal of riparian zone)	Industrial point sources
Fish Consumption		NOT ASSESSED				
Primary Contact		NOT ASSESSED – upper 2.6 miles NON SUPPORT- lower 3.8 miles	Objectionable deposits		Urban runoff	
Secondary Contact		NOT ASSESSED – upper 2.6 miles NON SUPPORT- lower 3.8 miles	Objectionable deposits		Urban runoff	
Aesthetics		SUPPORT – upper 2.6 miles NON SUPPORT- lower 3.8 miles	Objectionable deposits		Urban runoff	

RECOMMENDATIONS: SPICKET RIVER (SEGMENT MA84A-10)

- Excerpted from the biological monitoring technical memorandum (Appendix C):
  - While it may be difficult to eliminate or isolate some sources of urban runoff (stormwater, road/parking lot runoff, riparian disturbances) that threaten habitat and biological quality at the SR01, streambank stabilization and restoration of an adequate riparian buffer may help to alleviate the effects of some nonpoint source inputs to this portion of the river. In addition, a stream clean-up effort would greatly improve the aesthetic nature of this segment of the Spicket River.
  - Biomonitoring (macroinvertebrates and fish) is strongly recommended here during the next DEP. Merrimack River watershed survey in 2004, so as to continue to monitor the CSO abatement efforts of GLSD and any other river improvement measures that may take place.
- Support the efforts of the Merrimack River Watershed Council and the Spicket River Watershed Association to protect and restore the Spicket River.
- Evaluate water use in the Spicket River (inflow/outflow analysis) between (and including) Stevens Pond and the confluence with the Merrimack River regarding water withdrawals and wastewater discharges.
- As part of the WMA 5-year review, DEP should continue to evaluate Malden Mill Industries, Inc. compliance with their WMA permit limit.
- Determine need to develop and reissue Gencorp, Inc., Lawrence's permit (MA0003824).
- Evaluate the Draft and Final Long-Term CSO Control Plans for GLSD, and, when approved, require GLSD to implement CSO controls expeditiously to address these known sources of pollution.
- Collect water quality data, including bacteria data, to evaluate the effectiveness of GLSD CSO abatement projects.
- Continue to review water quality data (including any data from the ACOE project) to identify hotspots and integrate CSO and stormwater management activities to maximize water quality benefits.
- Support the efforts of the Spicket River Flood Hazard Mitigation Committee to reduce damages caused by flooding. Continue to review and evaluate the data (e.g., hydrologic, dam breech/inundation study) as they relate to water and habitat quality conditions in the Spicket River.

BARE MEADOW BROOK (SEGMENT MA84A-18)

Location: Headwaters, Methuen to confluence with Merrimack River, Methuen.
Size: 3.2 miles.
Classification: Class B.



Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	45%
Residential	37%
Open Land	7%

This segment is on the 1998 303(d) list of impaired waters, needing confirmation, for pathogens, siltation, organic enrichment/low DO, and turbidity (Table 3).

The Merrimack River Volunteer Environmental Monitoring Network (VEMN) conducted monitoring of fecal coliform bacteria, turbidity, dissolved oxygen, and temperature at three stations on Bare Meadow Brook in August and September 1999 and June through November 2000 (MRWC 2000).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:
Based on the available information there are no regulated water withdrawals or surface wastewater discharges in this subwatershed. It should be noted however that Methuen is a Phase II Stormwater community. Methuen must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:
The most recent benthic macroinvertebrate survey in Bare Meadow Brook was conducted by DEP in August 1990. Two stations, BMB01 (downstream from Northeast Rigging access road off of Ferry Street) and BMB01A (downstream of the Renfrew Street bridge) were sampled by DEP (Smith *et al.* 1990). Active sand and gravel operations were located in this subwatershed. Low flow conditions, erosion and sedimentation, and turbidity were evident (clogged stormdrains and culverts) at various locations along the brook. The RBP II analysis of the benthic community near Renfrew Street Bridge (station BMB01A) indicated moderate impacts (Smith et al. 1990).

In May 1999 the Bare Meadow Brook Stream Team conducted a shoreline survey along the Bare Meadow Brook. The team noted reduced flows in reaches of the brook resulting from crushed culverts and clogged storm drains, as well as beaver activity (downed trees, dams). Isolated areas of trash and debris were also noted (Kish and Roy 1999). High turbidity in Bare Meadow Brook was identified by the Bare Meadow Brook Stream Team behind the Delucca's Fence Company (MRWC 2000).

Too little current data are available to assess the designated uses of this segment of Bare Meadow Brook. The *Aquatic Life* and *Aesthetic* uses are, however, identified with an "Alert Status" because of erosion/sedimentation and objectionable deposits of trash and debris in isolated areas.

Bare Meadow Brook (MA84A-18) Use Summary Table

Aquatic Life*	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics *
Not Assessed				

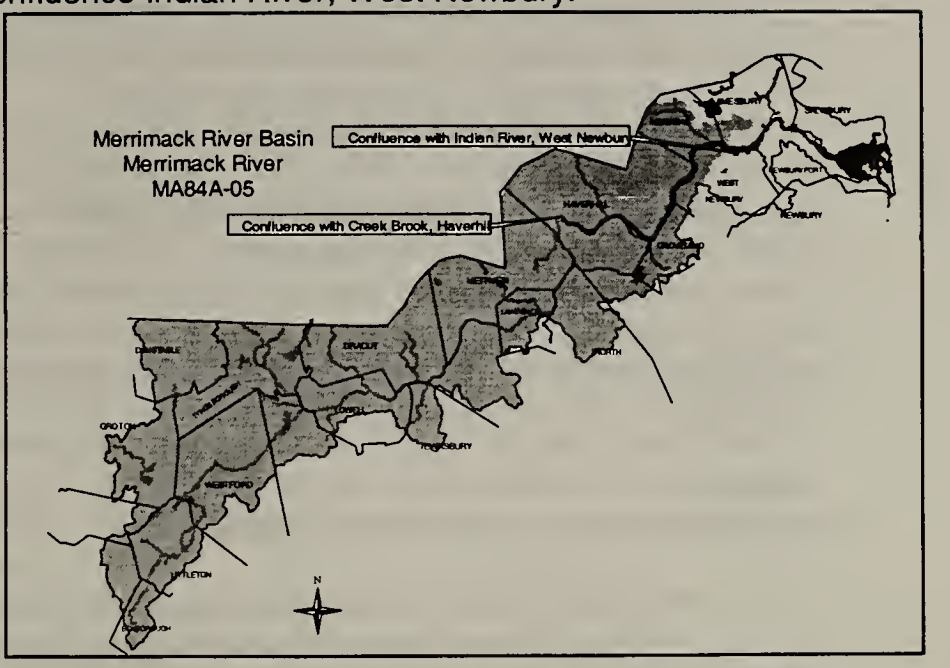
* "alert status" issues identified

RECOMMENDATIONS: BARE MEADOW BROOK (SEGMENT MA84A-18)

- Work with the Bare Meadow Brook Stream Team to implement their priority actions (Kish and Roy 1999).
- Implement BMPs to control sheet flow erosion from hillside along Old Ferry Road in Methuen and erosion from culvert behind Delucca Fence Company that contribute to high turbidity problems.
- Conduct a preliminary analysis to identify other potential sources of sediment inputs (e.g., sand and gravel operations) to Bare Meadow Brook. Develop and implement best management practices to reduce impacts of stormwater runoff.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

MERRIMACK RIVER (SEGMENT MA84A-05)

Location: Confluence Creek Brook, Haverhill to confluence Indian River, West Newbury.
Size: 2.6 square miles.
Classification: Class SB, Shellfish (R), CSO.



Land-use estimates (top three) for the Massachusetts portion of this subwatershed less the South Branch Souhegan River area (map inset, gray shaded area):

Forest	40%
Open Land	31%
Wetlands	8%

This segment is on the 1998 303(d) list of impaired waters for pathogens and unionized ammonia (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Haverhill Paperboard Corporation			31312803	Merrimack River	2.23	2.32*
Bradford Country Club**			31312804	Well #4 Peabody Brook	0.06	0.13*
Groveland Water Department*	3116000	9P231311601 (new source not increase in volume)	31311601	Well #4 GPW #3	0.41reg***	0.46***

* withdrawal did not exceed registration amount by more than 0.1 MGD (WMA threshold), **located along a tributary to this segment of the Merrimack River, *** indicates system-wide withdrawal; all sources are not necessarily within this segment.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLES D1 AND D2):

Haverhill Paperboard Corporation is permitted (MAG250961) to discharge (permit effective September 2000) 2.6 MGD (maximum daily) of non-contact cooling water to this segment of the Merrimack River.

Haverhill Water Pollution Control Facility (WPCF) is permitted (MA0101621) to discharge (permit issued April 1998) 18.1 MGD of treatment plant effluent via outfall # 001. The permit limit for whole effluent toxicity is $LC_{50} \geq 100\%$ using one test organism, *Pimephales promelas*. Other permit limits (maximum daily) include TRC (0.70 mg/l) and fecal coliform bacteria (400 cfu/100mls). None of the TRC measurements (TOXTD database) exceeded their permit limit (0.27 mg/L was the highest concentration). Haverhill WPCF is also permitted to discharge via 15 CSOs (upstream to downstream) along this segment of the Merrimack River as indicated below.

Outfall #025 Beach Street
Outfall #031 Front Street
Outfall #024 Upper Siphon
Outfall #023 River Street
Outfall #022 Railroad Bridge
Outfall #032 Bradford Avenue
Outfall #033 South Prospect Street
Outfall #034 Middlesex Street
Outfall #035 South Main Street
Outfall #019 Main Street-North
Outfall #016 Fire Station
Outfall #036 Ferry Street
Outfall #013 Lower Siphon
Outfall #010 Boardman Street

Outfall #001 Bates Bridge
Haverhill CSO discharges to the Little River include:
Outfalls #021A Middle Siphon,
Outfall #021E Little River South,
Outfall #021D Little River North, and
Outfall #021C Essex Street.

Merrimac WWTF is permitted (MA0101150) to discharge (permit issued August 1997) 0.45 MGD of treated sanitary and industrial wastewater via outfall # 001 to this segment of the Merrimack River. The permit limit for whole effluent toxicity is $LC_{50} \geq 50\%$ using two test organisms, *Mysidopsis bahia* and *Menidia beryllina*. Other permit limits (maximum daily) include TRC (1.0 mg/L April through October) and fecal coliform bacteria (400 cfu/100 mls). The highest effluent TRC concentration (TOXTD database) was 0.08 mg/L.

OTHER:
Haverhill Municipal Landfill (EPA undated):

> "The Haverhill Municipal Landfill is located adjacent to the Merrimack River in the City of Haverhill, Essex County, Massachusetts. The landfill consists of three tracts of land covering a total of about 73 acres. Prior to June 1981, two of the three tracts were reportedly used for disposal of municipal and commercial refuse, while the other reportedly received liquid wastes and sludges. In August 1981, the city contracted for a ground water study, evaluation of the landfill's impact on the local environment, and development of closure and monitoring plans. The results of that study indicate that ground water in the vicinity of the landfill is contaminated with volatile organic chemicals such as: benzene, toluene, and xylenes.
>
> Two municipal wells, which had supplied drinking water to approximately 6,000 people until they were closed in 1979 due to volatile organic contamination, lie within 1 mile of the site. These wells are being investigated as part of work at the Groveland Wells Site, which was placed on the National Priority List (NPL) in September 1983.
>
> Status (June 10, 1986): EPA is reviewing existing analytical and hydrogeologic information. The next step is a remedial investigation/feasibility study to determine the type and extent of contamination at the site and identify alternatives for remedial action."

USE ASSESSMENT:
AQUATIC LIFE

Habitat and streamflow

There is a 900-foot section of eroding riverbank along the Merrimack River in Haverhill. The erosion has threatened Riverside Avenue and a main lateral sewer pipe. An environmental impact report will be required for this project because it involves endangered species (bald eagle) habitat (Barber 2001b).

Toxicity

Ambient

Haverhill WWTP collects Merrimack River water (upstream of their discharge at the Route 125 bridge in Haverhill) for use as dilution water in their whole effluent toxicity tests. Between February 1998 and March 2001, survival of *P. promelas* exposed (48-hour) to the river water was good ($\geq$ 98%).

Merrimac WWTF collects Merrimack River water (upstream of their discharge at the mouth of Cobbler Brook) for use as dilution water in their whole effluent toxicity tests. Between April 1999 and April 2001 survival of *M. bahia* and *M. beryllina* exposed (48-hour) to the river water was good ($\geq$ 88%).

Effluent
Haverhill WWTP conducted 13 acute toxicity tests on their effluent using *P. promelas* between February 1998 and March 2001 on their treated effluent (Outfall #001) discharge. Whole effluent LC_{50}'s were all >100% effluent with the exception of the March 2001 test event (LC_{50} = 9.8%effluent).

Merrimac WWTF conducted six acute toxicity tests on their effluent using *M. bahia* and *M. beryllina* between April 1999 and April 2001 on their treated effluent (Outfall #001) discharge. Whole effluent LC_{50}'s were all >50% effluent ranging from 66 to 100% effluent. The *M. beryllina* were the more sensitive test organism.

Chemistry – water
Haverhill WWTP collects Merrimack River water (upstream of their discharge at the Route 125 bridge in Haverhill) for use as dilution water in their whole effluent toxicity tests. Between February 1998 and March 2001, a total of 13 reports were submitted. Merrimac WWTF collects Merrimack River water (upstream of their discharge at the mouth of Cobbler Brook) for use as dilution water in their whole effluent toxicity tests. Between April 1999 and April 2001 a total of six reports were submitted. Data from these reports are summarized below.

pH
Haverhill WWTP data (TOXTD) ranged from 6.2 to 7.3 SU. While two of 13 measurements were less than 6.5 SU, none reported since March 1999 have been less than 6.5 SU. Merrimac WWTF data (TOXTD) ranged from 6.8 to 7.2 SU

Suspended Solids
The maximum measurement from the Haverhill and Merrimac facilities (TOXTD) was 7.2 mg/L.

Ammonia-Nitrogen
The maximum measurement from the Haverhill and Merrimac facilities (TOXTD) was 0.78 mg/L.

Total Residual Chlorine
Haverhill WWTP data (TOXTD) ranged from BDL to 0.09 mg/L with two measurements that exceeded 0.05 mg/L. One measurement reported in the Merrimac WWTF data (TOXTD) exceeded 0.05 mg/L (0.06 mg/L).

Chemistry – tissue (whole fish)
Six species of fish collected (summer/fall 1998) by the USFWS from two reaches along this segment of the Merrimack River (Reach #2 located in the vicinity of Riverside, Haverhill/Groveland and Reach #1A located in the vicinity of Rocks Village, Haverhill/ Merrimac/Newbury) were submitted to the EPA Lexington Laboratory for analysis (McDonald 1999). Two whole fish composite samples of catfish (a three-fish and a four-fish) and an individual smallmouth bass were collected from Reach #2. An individual striped bass and an individual bluegill, two four-fish composite samples of herring and a two-fish composite sample of white sucker from Reach #1A were collected. All of these whole fish samples were analyzed for total mercury, lead and cadmium, organochlorine pesticides and total PCB (McDonald 1999). Cadmium and lead concentrations were below detection in all samples analyzed. The mercury concentrations in the whole fish samples ranged between 0.064 to 0.34 mg/Kg wet weight. The concentrations of organochlorine pesticides were all below the NAS/NAE guidelines for the protection of fish-eating wildlife. The concentrations of total PCB in the whole fish samples analyzed (data ranged from 0.72 to 6.8 mg/Kg wet weight), however, exceeded the NAS/NAE guidelines of 0.5 mg/Kg wet weight.

Due to the elevated concentration of PCB in whole fish collected from this segment of the Merrimack River (1.4 to 14 times the NAS/NAE guideline for the protection of fish-eating wildlife), the *Aquatic Life Use* is assessed as partial support. The effect(s), if any, of the multiple discharges (NPDES permittees, power plants, and CSOs) within this segment, or upstream, on aquatic life are currently unknown. With one exception (March 2001 Havehill WWTP whole effluent test), the limited ambient and whole effluent toxicity testing data indicated good water quality conditions. The 900-foot section of eroding riverbank

along the Merrimack River in Haverhill threatening Riverside Avenue and a main lateral sewer pipe is considered a major threat to the *Aquatic Life Use*.

SHELLFISHING

This reach of the Merrimack River is not delineated on DMF's October 2000 list of Shellfish Growing Areas, see Appendix E (DFWELE 2000). Therefore, the *Shellfishing Use* is not assessed for this segment.

PRIMARY* AND *SECONDARY CONTACT RECREATION

Fecal coliform bacteria samples were collected from three stations in this segment of the Merrimack River by DEP as part of the Microbial Indicator Study of the Merrimack River; near LePage Dock in Haverhill (downstream GLSD/upstream Haverhill CSOs), near downtown Haverhill (Fire Station downstream CSO/upstream POTW) and near Groveland below Bates Bridge (below Haverhill POTW) (Appendix G). Of the 12 samples collected at these three stations between August 1999 and April 2001, two counts exceeded exceeded 400 cfu/100 mls (Appendix G). The highest count (4300 cfu/100mLs) was representative of wet weather conditions in the Merrimack River downstream of Haverhill CSOs (Fire Station location) while the second highest count (680 cfu/100mLs), collected near LePage Dock, was representative of dry weather conditions (Appendix G, Table G1).

While Haverhill is implementing CSO pollution abatement strategies, the September 2000 Draft Haverhill Long-Term CSO Control Plan indicates that the Haverhill CSO outfalls presently activate up to 41 times per year for a total annual CSO volume of 69 million gallons during a year with typical precipitation (CDM 2000). Approximately 80% of the total CSO volume is discharged at the locations of the three siphon structures, CSOs 024, 021A, and 013.

It is best professional judgement that the bacteria data do not provide enough spatial/temporal coverage to capture the effect(s) of the multiple Haverhill CSO discharges that frequently occur within this segment of the Merrimack River. Although the status of the *Recreational Uses* is not assessed, these uses are identified with an "Alert Status". Sources of bacteria include the CSO discharges in Haverhill and the upstream communities as well as urban runoff. It should be noted, however, that the Haverhill WWTP is implementing CSO pollution abatement strategies.

AESTHETICS

The Merrimack River Watershed Council reports that this segment of the Merrimack River is generally aesthetically pleasing (Goodno 2001).

The *Aesthetics Use* is assessed as support. The 900-foot section of eroding riverbank along the Merrimack River in Haverhill threatening Riverside Avenue and a main lateral sewer plpe is considered a major threat to the *Aesthetics Use* and therefore it is identified with an "Alert Status".

Merrimack River (MA84A-05) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	PCB		Unknown	
Fish Consumption		NOT ASSESSED				
Shellfishing		NOT ASSESSED				
Primary Contact*		NOT ASSESSED				
Secondary Contact*		NOT ASSESSED				
Aesthetics*		SUPPORT				

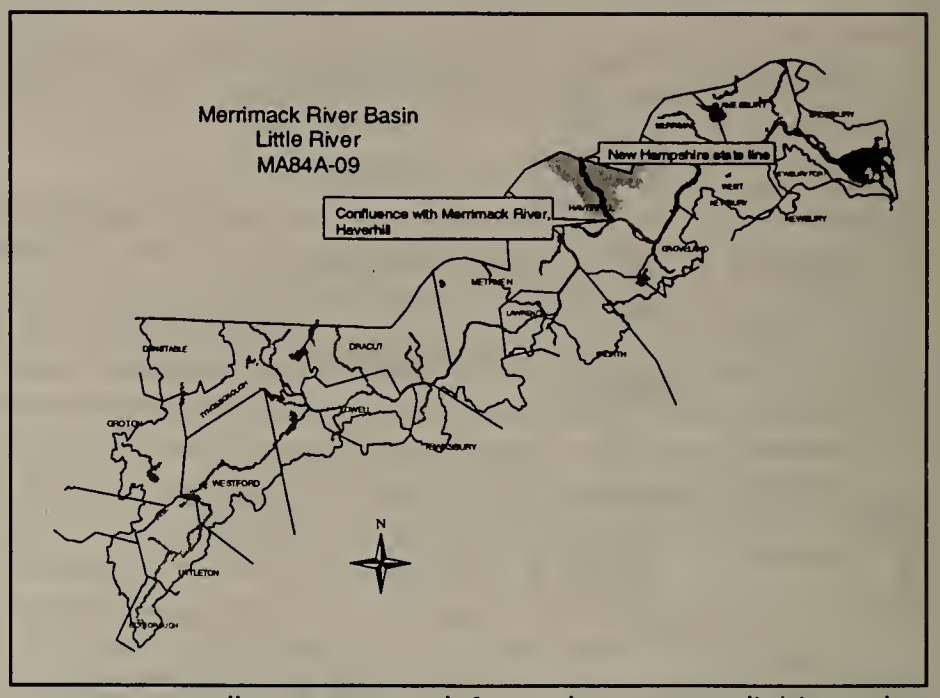
* "alert status" issues identified, details in this segment's USE ASSESSMENT section

RECOMMENDATIONS: MERRIMACK RIVER (SEGMENT MA84A-05)

- Conduct additional monitoring (e.g., passive water column PCB samplers as appropriate for estuarine areas, whole fish tissue), to determine the extent, and if necessary, source(s) of PCB contamination.
- Conduct biological monitoring (e.g., benthic macroinvertebrates, fish population) to evaluate the effect(s), if any, of the multiple upstream discharges (NPDES permittees) and the Haverhill WWTP discharge on aquatic life in this segment of the Merrimack River.
- If the Haverhill WWTP continues to have problems meeting their whole effluent toxicity testing limit, require a TIE/TRE.
- The whole effluent toxicity testing requirements for the Merrimac WWTF could be reduced to the more sensitive test organism (*M. beryllina*). Continue to carefully review the results of the facilities whole effluent toxicity tests (the effluent has exhibited some acute toxicity, however, the facility has been in compliance with their WET permit limit).
- Conduct environmental impact assessment and develop project to stabilize the 900 feet of eroded river-bank along Riverside Avenue.
- Evaluate the Draft and Final Long-Term CSO Control Plan for Haverhill and when approved, require Haverhill to implement CSO controls expeditiously to address these known sources of pollution.
- Collect water quality data, including bacteria data, to evaluate the effectiveness of Haverhills and other upstream CSO abatement projects.
- Continue to review water quality data (including any data from the ACOE project) to identify hotspots and integrate CSO and stormwater management activities to maximize water quality benefits.
- As part of the WMA 5-year review, DEP should continue to carefully monitor Haverhill Paperboard Corporation and Bradford Country Club's compliance with their WMA registrations and Groveland Water Department's compliance with their WMA registration and/or permit limit.

LITTLE RIVER (SEGMENT MA84A-09)

Location: State line Plaistow, NH/Haverhill, MA to confluence with Merrimack River, Haverhill.
Size: 4.3 miles.
Classification: Class B, Warm Water Fishery.



Land-use estimates (top three) for the subwatershed area in Massachusetts (map inset, gray shaded area):

Forest	36%
Residential	35%
Open Land	9%

This segment is on the 1998 303(d) list of impaired waters, needing confirmation, for pathogens (Table 3). The Little River Watershed Explorers conducted water quality sampling (temperature, fecal coliform, E. coli, dissolved oxygen, and turbidity) in the Little River watershed between July 1999 and September 2000) however no quality assurance information was available and, therefore, it could not be used for the use assessments.

WMA WATER WITHDRAWAL SUMMARY:
Based on the available information there are no WMA registered or permitted withdrawals in this subwatershed.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D1):
Haverhill WPCF is permitted (MA0101621) to discharge (permit issued April 1998) via four CSOs to the Little River as described below:

Outfalls #021A Middle Siphon,
Outfall #021E Little River South,
Outfall #021D Little River North, and
Outfall #021C Essex Street.

It should also be noted that Haverhill is a Phase II Storm Water community. Haverhill must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT:

AQUATIC LIFE

Habitat and streamflow

The lower 0.4 mile reach of the Little River (just upstream of the railroad crossing between Essex and Winter Streets and the confluence with the Merrimack River), is culverted underground. This channel alteration adversely impacts habitat quality.

Because of the lack of habitat in the lower 0.4-mile reach of the Little River (the stream is culverted and underground), the *Aquatic Life Use* is assessed as non-support. The upper 3.9 mile-reach of this segment is not assessed for this use.

PRIMARY* AND *SECONDARY CONTACT RECREATION* AND *AESTHETICS

While Haverhill is implementing CSO pollution abatement strategies, the September 2000 Draft Haverhill Long-Term CSO Control Plan indicates that the Haverhill CSO outfalls presently activate up to 41 times per year for a total annual CSO volume of 69 million gallons during a year with typical precipitation (CDM 2000). Approximately 80% of the total CSO volume is discharged at the locations of the three siphon structures, including CSO 021A, to the Little River. Haverhill's four CSO structures discharge into the culverted portion of the Little River.

Because of frequent CSO discharge(s) to the lower 0.4-mile reach of the Little River it is best professional judgement that the *Recreational* and *Aesthetic* uses are non-supported. The upper 3.9-mile reach is not assessed for these uses.

Little River (MA84A-09) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED upper 3.9 miles NON SUPPORT lower 0.4 miles	Habitat alteration		Channelization and habitat modification	
Fish Consumption		NOT ASSESSED				
Primary Contact		NOT ASSESSED upper 3.9 miles NON SUPPORT lower 0.4 miles	pathogens		CSO	
Secondary Contact		NOT ASSESSED upper 3.9 miles NON SUPPORT lower 0.4 miles	pathogens		CSO	
Aesthetics		NOT ASSESSED upper 3.9 miles NON SUPPORT lower 0.4 miles		Objectionable odor and turbidity	CSO	

RECOMMENDATIONS: LITTLE RIVER (SEGMENT MA84A-09)

- Evaluate the Draft and Final Long-Term CSO Control Plan for Haverhill, and, when approved, require Haverhill to implement CSO controls expeditiously to address these known sources of pollution.
- Collect water quality data, including bacteria data, to evaluate the effectiveness of CSO abatement projects.
- Continue to review water quality data (including any data from the ACOE) to identify hotspots and integrate CSO and stormwater management activities to maximize water quality benefits.
- Work with the Little River Watershed Explorers to develop a QAPP for their sampling plan.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

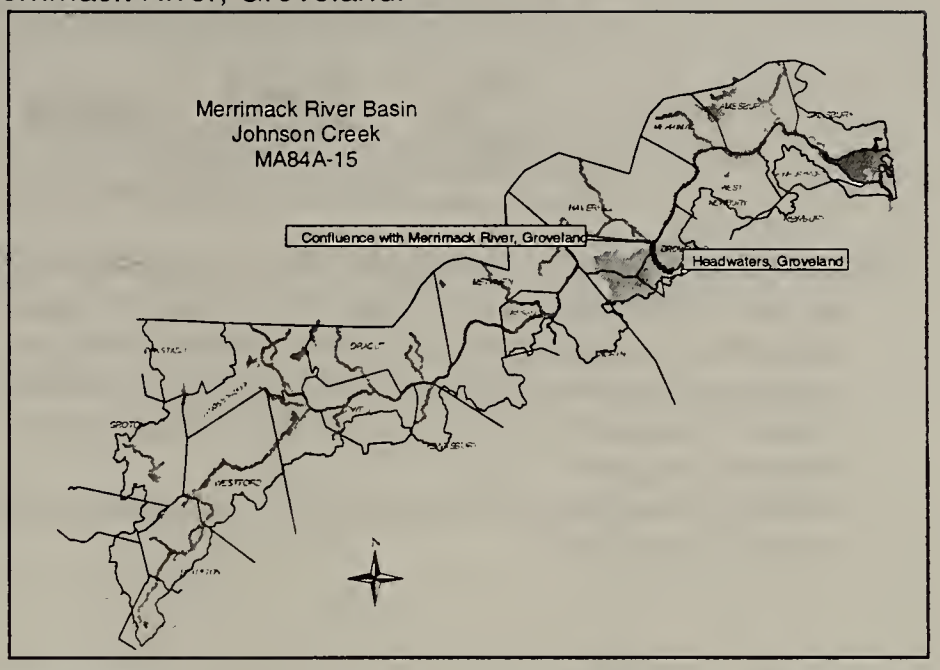
JOHNSON CREEK (SEGMENT MA84A-15)

Location: Headwaters to confluence with Merrimack River, Groveland.
Size: 3.1 miles.
Classification: Class B.

Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	89%
Residential	5%
Open Land	3%

This segment is on the 1998 303(d) list of impaired waters, needing confirmation, for siltation (Table 3).



WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Groveland Water Department	3116000	9P231311601 (new source not increase in volume)	31311601	01G	0.41*	0.46**

* indicates system-wide withdrawal; all sources are not necessarily within this segment, ** withdrawal did not exceed registration amount by more than 0.1 MGD (WMA threshold)

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D2):

The town of Groveland, Mill Pond Ground Water Intercept System is permitted (MA0102661) to discharge (permit issued April 1983) 0.5 MGD of treated groundwater (air stripper to remove trichloroethylene – TCE) via outfall # 001 and 0.35 MGD of treated groundwater via outfall #002 to Johnson Creek and Brindle Brook. The permit contained limits for tricholorethylene (100 µg/l maximum daily) and tetracholorethylene (75 µg/l maximum daily). The permit on file was for test well site water that was to expire 365 days from commencement of discharge. A permanent treatment system has been constructed at the site and because the discharge is covered under the Superfund Program, the NPDES permit will be terminated. However, water quality sampling will continue to be required.

It should also be noted that both Groveland and Haverhill are Phase II Stormwater communities. These communities must apply for permit coverage for their municipal drainage systems and are required to develop, implement and enforce their storm water management programs by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:

The most recent benthic macroinvertebrate survey in Johnson Creek was conducted in July 1990. Two stations, JC03 (downstream from Center Street bridge) and JC02 (downstream from the Groveland Well Superfund site discharge) were sampled by DEP (Smith *et al.* 1990). The benthic macroinvertebrate communities were found to be non-impaired (RBP II analysis. Deposition (sand bar formation) was noted at the upstream sampling location.

Too few current data are available to assess the designated uses of Johnson Creek.

Johnson Creek (MA84A-15) Use Summary Table

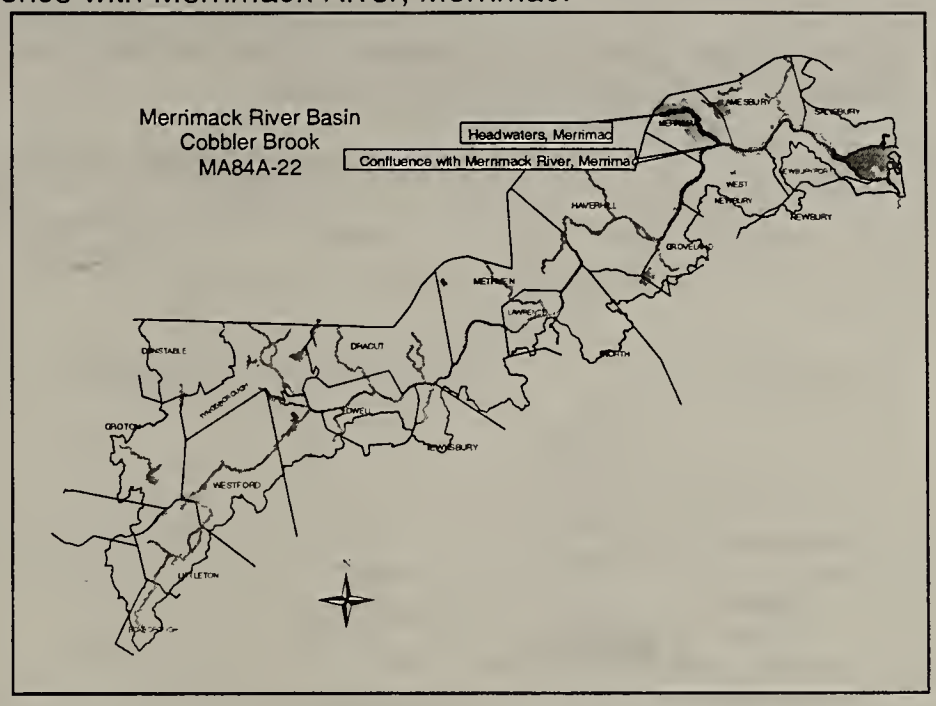
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: JOHNSON CREEK (SEGMENT MA84A-15)

- As part of the WMA 5-year review, DEP should continue to carefully monitor Groveland Water Department's compliance with their WMA registered and permitted limit(s).
- A habitat quality evaluation of Johnson Creek should be conducted and particular attention should be made to document areas of erosion and sedimentation. Develop and implement BMPs to control storm water runoff.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

COBBLER BROOK (SEGMENT MA84A-22)

Location: Headwaters, Merrimack to confluence with Merrimack River, Merrimac.
Size: 4.5 miles.
Classification: Class B, Cold Water Fishery.



Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):

Forest	53%
Residential	28%
Agriculture	8%

This segment is on the 1998 303(d) list of impaired waters, needing confirmation, for unknown toxicity (Table 3).

The Merrimack River Volunteer Environmental Monitoring Network (VEMN) conducted monitoring of fecal coliform bacteria, turbidity, dissolved oxygen, and temperature at multiple stations along Cobbler Brook in August and September 1999 and June through November 2000 (MRWC 2000).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:
Based on the available information there are no regulated water withdrawals or surface wastewater discharges in this subwatershed. According to EPA, Coastal Metal Finishing, Inc. of Merrimack (MA0021628) no longer discharges to Cobbler Brook because they tied into the Merrimac WWTF.

It should also be noted that Merrimac is listed as being a Phase II storm water community. Merrimac must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT:

AQUATIC LIFE

Biology

In July 1999 DWM conducted an RBP III benthic macroinvertebrate survey (station CB01) in Cobbler Brook upstream from Mill Street in Merrimac. The benthic macroinvertebrate data were found to be 58% comparable to the Fish Brook regional reference station (station FB00) in the Ipswich River Basin. Based on the RBP III analysis, the benthic community was slightly impacted (Appendix C).

Habitat and Flow

Although Cobbler Brook received the highest habitat assessment score during the 1999 Merrimack River watershed survey, shallow water (channel only about half-full) limited available fish habitat. A steep eroding section of the stream bank was also present. Yard waste deposits (grass clippings, trash) likely originated from the adjacent residence (Appendix C).

Based on the benthic macroinvertebrate community analysis the *Aquatic Life Use* of Cobbler Brook is assessed as partial support. Although the cause of impairment is unknown, it is suspected that water quality degradation may result from organic enrichment—and probably to a lesser degree habitat constraints related to riparian disturbances and seasonal low-flow conditions. Impoundment effects, localized nonpoint source pollution, and unknown anthropogenic perturbations originating upstream (possibly in the vicinity of downtown Merrimac) may also pose a threat to biological potential in this portion of Cobbler Brook (Appendix C).

AESTHETICS

A shoreline survey of Cobbler Brook was carried out by the MRWC and the Cobbler Brook Stream Team volunteers in May 1999. The team noted objectionable deposits of trash and debris along the

majority of Cobbler Brook (Carley 1999). These conditions were also noted by DWM at their benthic macroinvertebrate sampling station (Appendix C).

Because of the objectionable deposits of trash and debris along the majority of Cobbler Brook, the *Aesthetics Use* is assessed as non-support.

Cobbler Brook (MA84A-22) Use Summary Table

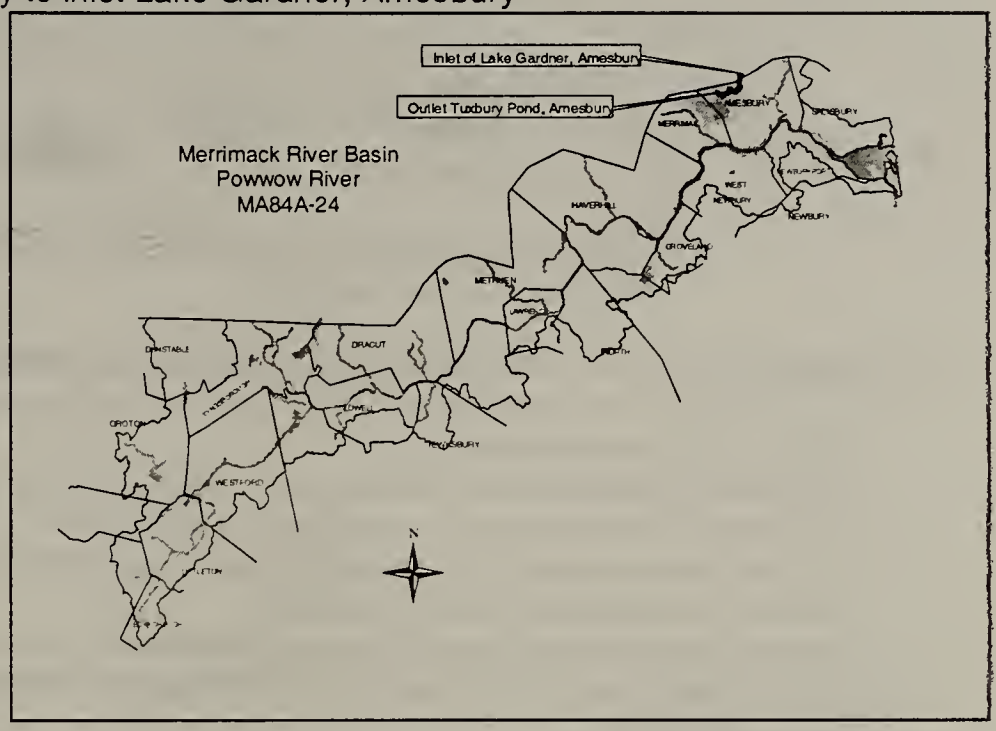
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	unknown	Organic enrichment, habitat and flow alteration	unknown	Urban runoff, hydromodification (impoundment, streambank modification
Fish Consumption		NOT ASSESSED				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NON SUPPORT	Objectionable deposits		Dumping	

RECOMMENDATIONS: COBBLER BROOK (SEGMENT MA84A-22)

- Work with the Cobbler Brook Stream Team to implement their priority actions (Carley 1999).
- As provided in Appendix C of this report:
  - ➢ Outreach efforts are recommended to educate nearby residents on how improper yard waste disposal can impact aquatic life "in their own back yard," as well as the importance of maintaining a riparian buffer zone.
  - ➢ Local clean-up efforts to remove instream trash and debris should be encouraged.
  - ➢ While toxic effects—possibly attributable to the *Coastal Metal Finishing* discharge—are no longer evident here, as was the case during the 1990 biosurvey, depleted oxygen levels may contribute to the reduction of pollution-sensitive EPT taxa observed during the 1999 survey. Biomonitoring is recommended here during the next DEP Merrimack River watershed survey in 2004. Fish population sampling, which has not historically been performed by DEP in this subwatershed, should accompany the macroinvertebrate sampling effort. In addition, monitoring physico-chemical parameters—especially dissolved oxygen and pH—may aid in the interpretation of future biomonitoring data collected here.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

POWWOW RIVER (SEGMENT MA84A-24)

Location: Outlet Tuxbury Pond, Amesbury to inlet Lake Gardner, Amesbury
Size: 3.4 miles.
Classification: Class A.



Land-use estimates (top three) for the subwatershed area in Massachusetts (map inset, gray shaded area):

Forest	41%
Agricultural	17%
Residential	16%

This segment (formerly part of segment MA84A-07) is on the 1998 303(d) list of impaired waters, needing confirmation, for pathogens, suspended solids, noxious aquatic plants and turbidity (Table 3).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Amesbury Water Treatment Facility	3007000		31300701	01G 02G 01S	1.23	1.75*

* withdrawal exceed registration amount by more than 0.1 MGD (WMA threshold).

The Amesbury Water Treatment Facility has applied for a WMA permit, which is currently under review by DEP (Casella 2001).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D1):

Amesbury Water Treatment Plant (MA0102822) discharges via outfall serial #001 and 002 to this segment of the Powwow River. A notice of non-compliance for total suspended solids and settleable solids has been issued for chronic violations over the last several months and sporadically over the last several years. Operational deficiencies will be corrected during calender years 2001 and 2002 (Casella 2001).

It should be noted, however, that Amesbury is a Phase II Stormwater community. Amesbury must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:

The Powwow River Watershed Association conducted water quality sampling (temperature, conductivity, pH, dissolved oxygen, and turbidity) in the Powwow River watershed between November 1999 and September 2000. No quality assured data, however, has been collected and therefore all uses are currently not assessed. The *Aesthetics Use* however is identified with an "Alert Status" because of the operational problems at the Amesbury WTP.

Powwow River (MA84A-24) Use Summary Table

Aquatic Life	Fish Consumption	Drinking Water*	Primary Contact	Secondary Contact	Aesthetics**
Not Assessed					

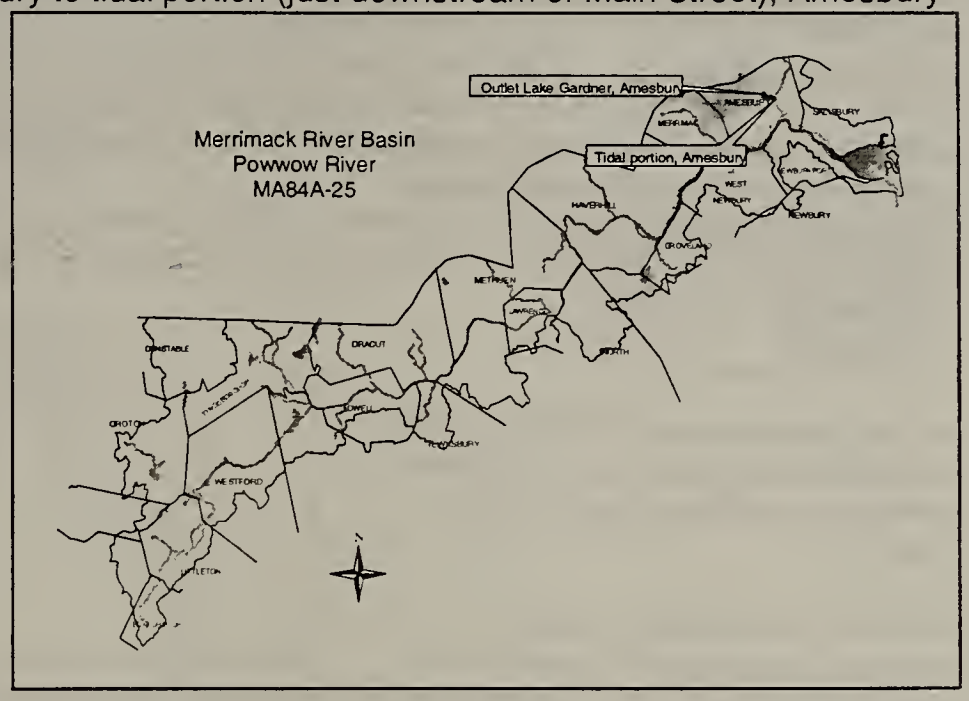
* The DEP Drinking Water Program maintains current drinking water supply data,
** "Alert Status" issues identified

RECOMMENDATIONS: POWWOW RIVER (SEGMENT MA84A-24)

- As part of the WMA 5-year review, DEP should continue to follow up on Amesbury Water Treatment Facility's WMA exceedances.
- Monitor the effectiveness of the operational improvements at the Amesbury Water Treatment Plant (MA0102822). Develop and reissue their NPDES permit.
- When available review DEP's Powwow River Source Water Protection Project findings and implement recommendations (Appendix F).
- Work with the Powwow River Watershed Association to develop a QAPP for their sampling plan.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

POWWOW RIVER (SEGMENT MA84A-25)

Location: Outlet Lake Gardner, Amesbury to tidal portion (just downstream of Main Street), Amesbury
Size: 0.59 miles.
Classification: Class B, Warm Water Fishery.



Land-use estimates (top three) for the subwatershed area in Massachusetts (map inset, gray shaded area):

Forest	39%
Residential	19%
Agriculture	17%

This segment (formerly part of segment MA84A-07) is on the 1998 303(d) list of impaired waters, needing confirmation, for pathogens, suspended solids, noxious aquatic plants and turbidity (Table 3).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:
Based on the available information there are no regulated water withdrawals or surface wastewater discharges in this subwatershed. It should be noted, however, that Amesbury is a Phase II Stormwater community. Amesbury must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:
No quality assured data has been collected and, therefore, all uses are currently not assessed.

Powwow River (MA84A-25) Use Summary Table

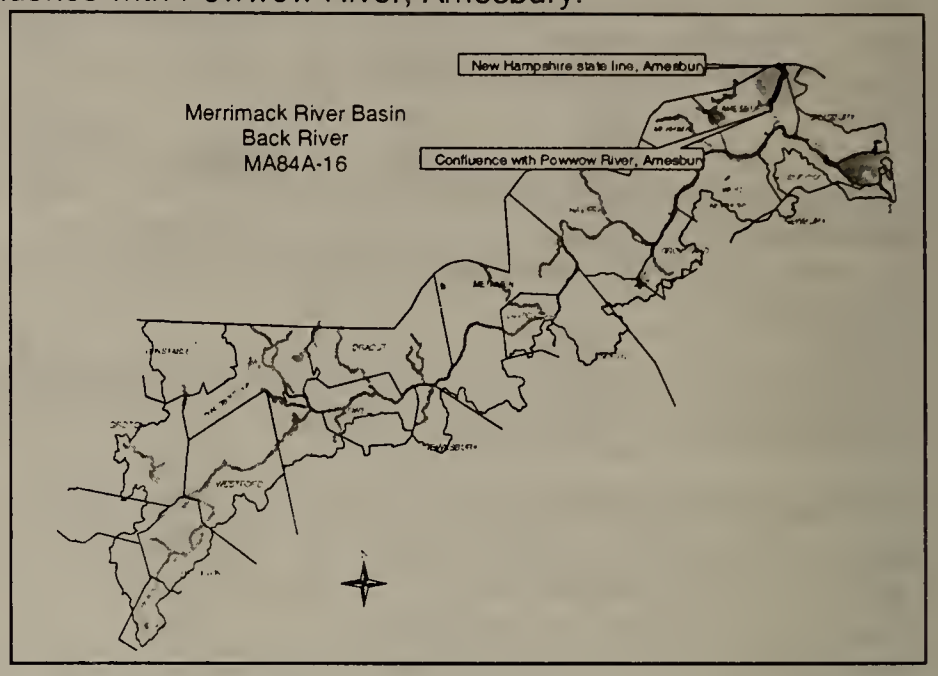
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: POWWOW RIVER (SEGMENT MA84A-25)

- Conduct field reconnaissance to identify any areas that may be of concern to this segment of the Powwow River. Develop a sampling plan for collecting quality assured data as deemed necessary.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

BACK RIVER (SEGMENT MA84A-16)

Location: New Hampshire state line to confluence with Powwow River, Amesbury.
Size: miles.
Classification: Class B.



Land-use estimates (top three) for the subwatershed aarea in Massachusetts (map inset, gray shaded area):

Forest	39%
Residential	29%
Agriculture	21%

This segment is on the 1998 303(d) list of impaired waters, needing confirmation, for siltation, pathogens and turbidity (Table 3).

The Town of Amesbury ceased stockpiling snow (at the banks of the PowWow) and salt laden sediment at the DPW yard area in March 2001. DEP authorized a new, secured site away from any surface water locations (Casella 2001).

WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Salisbury Water Supply Company	3259000		31325901	06G	0.25	0.88*

* withdrawal exceeded registration amount by more than 0.1 MGD (WMA threshold)

NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated surface wastewater discharges to the Back River.

It should be noted, however, that Amesbury is a Phase II Stormwater community. Amesbury must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:

The most recent benthic macroinvertebrate survey in the Back River was conducted in August 1990. Two stations, ABR03 (upstream of Fern Avenue Bridge) and ABR01 (upstream of the R street bridge) were sampled by DEP (Smith *et al.* 1990). Severe sedimentation was documented at the upstream station. The benthos were found to be non/moderately impaired (RBP II analysis). The benthic community at ABR01 was moderately impaired (RBP II analysis). At the time of sampling there was evidence of urban runoff and erosion problems. The Powwow River Watershed Association conducted water quality sampling (temperature, conductivity, pH, dissolved oxygen, and turbidity) in the Back River watershed between November 1999 and September 2000. No quality assured data, however, has been collected and, therefore, all uses are currently not assessed.

Back River (MA84A-16) Use Summary Table

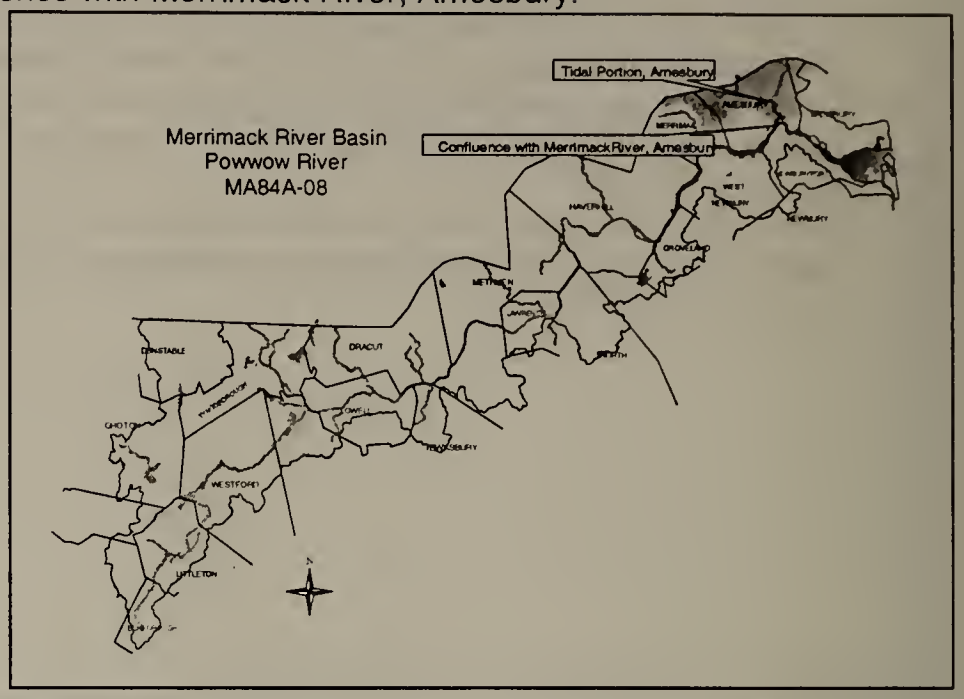
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: BACK RIVER (SEGMENT MA84A-16)

- The Salisbury Water Supply Company appears to be out of compliance with their WMA registration. As part of the WMA 5-year review, DEP should continue to follow-up on their WMA exceedance of registration threshold and take appropriate action as deemed necessary.
- A habitat quality evaluation of the Back River should be conducted and particular attention should be made to document areas of erosion and sedimentation. Develop and implement BMPs to control storm water runoff.
- Work with the Powwow River Watershed Association to develop a QAPP for their sampling plan.
- Additional monitoring of this segment is necessary to determine if it should be retained or deleted from the 303(d) list.

POWWOW RIVER (SEGMENT MA84A-08)

Location: Tidal portion, Amesbury to confluence with Merrimack River, Amesbury.
Size: 0.05 square miles.
Classification: Class SB, Shellfishing Restricted.



Land-use estimates (top three) for the subwatershed in Massachusetts (map inset, gray shaded area):

Forest	37%
Residential	25%
Agriculture	16%

An evaluation of land-use within the Powwow River Watershed was recently completed by the Merrimack River Watershed Council (Monnelly and Strauss 2001b). It should also be noted that a Powwow River Impervious Surfaces Pilot Project is scheduled to begin in the Fall 2001 to help communities implement BMPs to minimize and mitigate current and future impacts of impervious surfaces (Monnelly and Strauss 2001b).

This segment is on the 1998 303(d) list of impaired waters for pathogens (Table 3).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information there are no regulated water withdrawals or surface wastewater discharges in this subwatershed. It should be noted, however, that Amesbury is a Phase II Stormwater community. Amesbury must apply for permit coverage for their municipal drainage system and is required to develop, implement and enforce their storm water management program by March 2003 (Domizio 2001).

USE ASSESSMENT SUMMARY:

No quality assured data has been collected and, therefore, all uses are currently not assessed. This reach of the Powwow River is not delineated on DMF's October 2000 list of Shellfish Growing Areas, see Appendix E (DFWELE 2000). Therefore, the *Shellfishing Use* is not assessed for this segment.

Powwow River (MA84A-08) Use Summary Table

Aquatic Life	Fish Consumption	Shellfishing	Primary Contact	Secondary Contact	Aesthetics
Not Assessed					

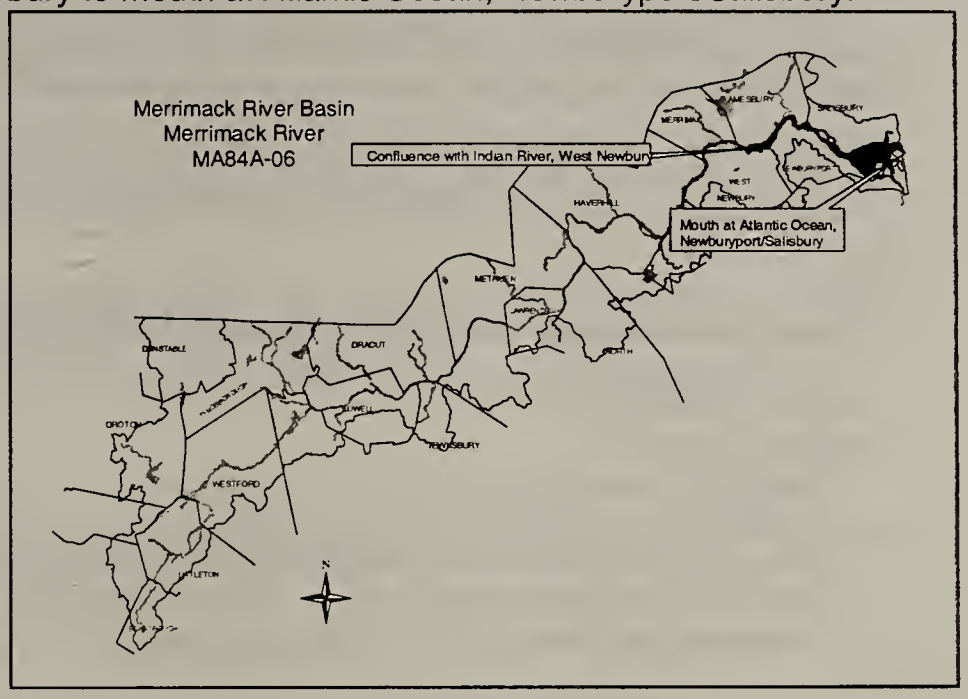
RECOMMENDATIONS: POWWOW RIVER (SEGMENT MA84A-08)

- Review the MRWC Powow River Watershed Assessment and support their efforts to protect the Powwow River Watershed (Monnelly and Strauss 2001b).

MERRIMACK RIVER (SEGMENT MA84A-06)

Location: Confluence Indian River, West Newbury to mouth at Atlantic Ocean, Newburyport/Salisbury.
Size: 4.37 square miles.
Classification: Class SB.

Land-use estimates are not available for this subwatershed area. This segment is on the 1998 303(d) list of impaired waters for pathogens (Table 3).



WMA WATER WITHDRAWAL SUMMARY (APPENDIX D, TABLE D3):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Newburyport Water Department	3206000	9P31320601	31320601	Indian Hill Reservoir Artichoke Reservoir Well #1 Bartlett Spring Pond Well #2	2.2reg 0.29per 2.49total	2.2
West Newbury Water Department	3324000	9P231332401		Wellfield #1 324-01G	0.16	0.1

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLES D1 AND D2):

Amesbury WWTP is permitted (MA0101745) to discharge (permit issued January 1998) 1.9 MGD of treated sanitary and industrial wastewater via outfall #001 to this segment of the Merrimack River. The permit limit for whole effluent toxicity is $LC_{50} \geq 50\%$ using two test organisms, *Mysidipsis bahia* and *Menidia beryllina*. The facility's permit limit for TRC (maximum daily) is 1.0 mg/l. The highest effluent TRC concentration (TOXTD database) was 0.33 mg/L. The town of Amesbury is under a consent order to upgrade the WWTF (Casella 2001).

Salisbury Sewer Commission is permitted (MA0102873) to discharge (permit issued October 1997) 1.3 MGD of treated effluent via outfall #001 to a tidal creek tributary of this segment of the Merrimack River. The permit limit for whole effluent toxicity is $LC_{50} \geq 100\%$ using two test organisms, *Mysidipsis bahia* and *Menidia beryllina*.

Ferraz Shawmut Inc. (formerly Gould Electronics), Newburyport is permitted (MA0000281) to discharge (September 1997) 0.06 MGD (maximum daily) of treated process wastewater and non-contact cooling water via outfall #001 to this segment of the Merrimack River. The permit limit for whole effluent toxicity is $LC_{50} \geq 50\%$ using two test organisms, *Mysidipsis bahia* and *Menidia beryllina*.

Newburyport WPCF is permitted (MA0101427) to discharge (permit issued September 1998) 3.4 MGD (average monthly) of treated effluent via outfall #001 to a tidal creek tributary to this segment of the Merrimack River. The permit limit for whole effluent toxicity is $LC_{50} \geq 100\%$ using two test organisms, *Mysidipsis bahia* and *Menidia beryllina*. The facility's permit limit for TRC (maximum daily) is 0.3 mg/L. The highest effluent TRC concentration (TOXTD database) was 0.19 mg/L. The facility is undergoing approved process modifications to remove excess inflow/infiltration (I/I) and to provide water and sewer to

the residents of Plum Island, which will provide beneficial water quality improvements over the next several years.

Newburyport WTP is permitted (MAG640018) to discharge (permit effective August 2001) 0.171 MGD of water treatment plant effluent to this segment of the Merrimack River.

OTHER:
Marine Pumpout Station at Cashman Park Boat Ramp, Newburyport. Facility operates for three seasons 24/hours a day.

Marine Pumpout Station at City Dock at Joppa Flats Park, Newburyport.

USE ASSESSMENT:
AQUATIC LIFE

Toxicity

Ambient

Amesbury WWTP collects Merrimack River water (upstream of their discharge pipe in Amesbury) for use as dilution water in their whole effluent toxicity tests. Between April 1996 and August 1997, survival of *M. bahia* and *M. beryllina* exposed (48 -hour) to the river water was good (≥ 90%).

Salisbury WWTP collects Merrimack River water (off of Deer Island in Amesbury) for use as dilution water in their whole effluent toxicity tests. Between December 1997 and February 2001, survival of *M. bahia* and *M. beryllina* exposed (48 -hour) to the river water was good (≥ 75%).

Ferraz Shawmut Inc. (formerly Gould Electronics), Newburyport also collects Merrimack River water (approximately 200 yards from their discharge pipe in Newburyport) for use as dilution water in their whole effluent toxicity tests. Between May 1996 and November 2000, survival of *M. bahia* and *M. beryllina* exposed (48 -hour) to the river water was good (≥ 90%).

Newburyport WWTP collects Merrimack River water (upstream of their discharge Near Hiltons Fishing Dock in Newburyport) for use as dilution water in their whole effluent toxicity tests. Between March 1996 and March 2001, survival of *M. bahia* and *M. beryllina* exposed (48 -hour) to the river water was good (≥ 75%).

Effluent

Amesbury WWTP conducted 3 acute toxicity tests on their effluent using both *M. bahia* and *M. beryllina* between December 1997 and February 2001 on their treated effluent (Outfall #001) discharge. Whole effluent LC_{50}'s were all >75% effluent.

Salisbury WWTP conducted 18 acute toxicity tests on their effluent using both *M. bahia* and *M. beryllina* between April 1996 and August 1997on their treated effluent (Outfall #001) discharge. Whole effluent LC_{50}'s were all >100% effluent.

Ferraz Shawmut Inc. (formerly Gould Electronics), Newburyport conducted 10 acute toxicity tests on their effluent using both *M. bahia* and *M. beryllina* between May 1996 and November 2000 on their treated effluent (Outfall #001) discharge. The facility's LC_{50}'s ranged from 21.4 to >100% effluent, and four of the ten tests did not meet the permit limit. *M. bahia* was consistently the more sensitive test organism.

Newburyport WWTP conducted 18 acute toxicity tests on their effluent using both *M. bahia* and *M. beryllina* between March 1996 and March 2001on their treated effluent (Outfall #001) discharge. Whole effluent LC_{50}'s ranged between 51.2 and >100% effluent. While four test results did not meet the facility's permit limit (i.e., ranging between 51.2 and 87.1% effluent), it should also be noted that none of the tests conducted since December 1997 have violated the LC_{50} permit limit.

Chemistry – water

Amesbury WWTP collects Merrimack River water (upstream of their discharge pipe in Amesbury) for use as dilution water in their whole effluent toxicity tests. Between December 1997 and February 2001 a total of three reports were submitted.

Salisbury WWTP collects Merrimack River water (off of Deer Island in Amesbury) for use as dilution water in their whole effluent toxicity tests. Between April 1996 and August 1997 a total of 18 reports were submitted.

Ferraz Shawmut Inc. (formerly Gould Electronics), Newburyport also collects Merrimack River water (approximately 200 yards from their discharge pipe in Newburyport) for use as dilution water in their whole effluent toxicity tests. Between May 1996 and November 2000 a total of 10 reports were submitted.

Newburyport WWTP collects Merrimack River water (upstream of their discharge Near Hiltons Fishing Dock in Newburyport) for use as dilution water in their whole effluent toxicity tests. Between March 1996 and March 2001 a total of 18 reports were submitted.

Collectively, data from these 49 reports (information maintained in the TOXTD database) are summarized below.

pH

pH ranged from 5.8 to 8.7 SU. Five of the 49 measurements (10%) were < 6.5 and one measurement was >8.5 SU.

Suspended Solids

Suspended solids concentrations did not exceed 32 mg/L (only one measurement exceeded 25 mg/L).

Ammonia-Nitrogen

With one exception, measurements of ammonia-nitrogen did not exceed 0.58 mg/L (the highest measurement was 2.4 mg/L).

Total Residual Chlorine

All TRC measurements were below the minimum quantification level of 0.05 mg/L.

Chemistry – tissue (whole fish)

Five species of fish were collected (summer/fall 1998) by the USFWS from the lower end of this segment of the Merrimack River (Reach #1 located in the vicinity of Carr and Ram islands, Salisbury/Newburyport). These samples, an individual white perch, an individual striped bass, a two-fish composite of white sucker, a four-fish composite of white catfish and a five-fish composite of white catfish, were submitted to the EPA Lexington Laboratory for analysis (McDonald 1999). These whole fish composite samples were analyzed for total mercury, lead and cadmium, organochlorine pesticides and total PCB (McDonald 1999). Cadmium and lead concentrations were below detection in all samples analyzed. The mercury concentrations in the whole fish samples ranged between 0.09 to 0.25 mg/Kg wet weight. The concentrations of organochlorine pesticides were all below the NAS/NAE guidelines for the protection of fish-eating wildlife. The concentrations of total PCB in the whole fish samples analyzed (data ranged from 2.01 to 2.88 mg/Kg wet weight), however, exceeded the NAS/NAE guidelines of 0.5 mg/Kg wet weight.

Due to the elevated concentration of PCB in whole fish collected from this segment of the Merrimack River (4 to 6 times the NAS/NAE guideline for the protection of fish-eating wildlife), the *Aquatic Life Use* is assessed as partial support. The effect(s), if any, of the multiple discharges (NPDES permittees) within this segment on aquatic life are currently unknown. With the exception of acute toxicity in the Ferraz Shawmut Inc. effluent, the limited ambient and whole effluent toxicity testing data indicated good water quality conditions.

SHELLFISHING

The DMF shellfish growing area (N2.0) contained within this segment of the Merrimack River (east of Route 95) is prohibited according to the Shellfish Classification and Management Program, see Appendix E (DFWELE 2000). There are no DMF designated shellfish growing areas upstream (west) of the Route 95 bridge, Salisbury/Newburyport.

Based on the DMF shellfishing status information, the upper 0.862 square miles of this segment (upstream of Route 95) is currently not assessed for the *Shellfishing Use.* The *Shellfishing Use* is assessed as non-support for 3.508 square miles (east of Route 95).

PRIMARY* AND *SECONDARY CONTACT RECREATION

Fecal coliform data for 11 classification sampling stations for this segment of the Merrimack River reported by DMF between February 1996 and July 2000 DMF ranged between 2.9 to >2400 cfu/100 mLs with a total of 717 samples collected (438 samples were collected during the primary contact recreational season) (Kennedy 2001). Only 16 samples (4%) exceeded 400 cfu/100 ml during the primary contact recreational season while only six samples (1%) exceeded 2000 cfu/100 ml during the secondary contact recreational season. The geometric mean at any individual sampling station did not exceed 68 cfu/100 mLs. The data set represents both wet and dry weather sampling conditions.

It should also be noted that four tributaries along the northern shore of the Merrimack River Estuary were also sampled by DMF (Morrill, Middle, Shad and Black Rock creeks). The highest fecal coliform counts were in Black Rock Creek (maximum > 2,400 cfu/100 mLs) following heavy rain events although only one sample out of 72 exceeded 2,000 cfu/100 mLs. The geometric mean at this site was 59 cfu/100 mLs.

Based on these data, both the *Primary* and *Secondary Contact Recreational Uses* are assessed as support.

AESTHETICS

The MRWC reports that this segment of the Merrimack River is generally aesthetically pleasing (Goodno 2001).

The *Aesthetics Use* is assessed as support.

Merrimack River (MA84A-06) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	PCB		Unknown	
Fish Consumption		NOT ASSESSED				
Shellfishing		NOT ASSESSED 0.86 square miles NON SUPPORT 3.51 square miles	Pathogens		Unknown	
Primary Contact		SUPPORT				
Secondary Contact		SUPPORT				
Aesthetics		SUPPORT				

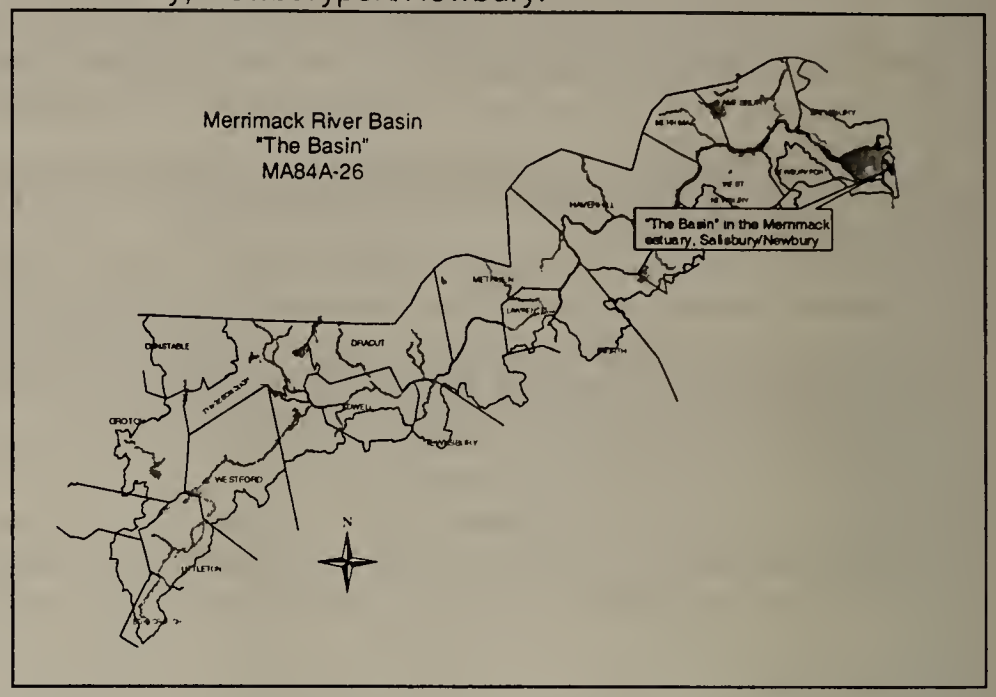
* "alert status" issues identified, details in this segment's USE ASSESSMENT section

RECOMMENDATIONS: MERRIMACK RIVER (SEGMENT MA84A-06)

- Conduct additional monitoring (e.g., passive water column PCB samplers as appropriate for estuarine areas, whole fish tissue), to determine the extent, and if necessary, source(s) of PCB contamination.
- Conduct biological monitoring (e.g., benthic macroinvertebrates, fish population) to evaluate the effect(s), if any, of the multiple discharges (NPDES permittees) on aquatic life in this segment of the Merrimack River.
- If Ferraz Shawmut Inc. continues to have problems meeting their whole effluent toxicity testing limit, require a TIE/TRE.
- Monitor to evaluate/document improvements in water quality conditions as a result of improvements at the Newburyport WPCF and the sewering of Plum Island.
- As part of the WMA 5-year review, DEP should continue to evaluate Newburyport Water Department's compliance with their WMA registration and/or pemit limit and West Newbury Water Department's compliance with their WMA pemit limit.

MERRIMACK RIVER (SEGMENT MA84A-26)

Location: "The Basin" in the Merrimack River Estuary, Newburyport/Newbury.
Size: 0.17 square miles.
Classification: Class SA.



Land-use estimates are not available for this subwatershed area. This segment was included as part of MA84A-06 which was listed on the 1998 303(d) list of impaired waters for pathogens (Table 3).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information there are no regulated water withdrawals or surface wastewater discharges in this segment.

It should be noted, however, that the towns of Newbury and Newburyport have decided to expand water and sewer to Plum Island. A draft Environmental Impact Report has been submitted and is in the Massachusetts Environmental Policy Act review process. Local septic system failures have been documented (contaminated drinking water wells with nitrates, volatile organic compounds and bacteria) (Casella 2001).

USE ASSESSMENT:

AQUATIC LIFE

Because of the elevated concentration of PCB documented in whole fish collected from the Merrimack River in 1998 (McDonald 1999), the *Aquatic Life Use* for this segment is identified with an "Alert Status".

SHELLFISHING

The entire 0.17 square mile of "The Basin" (DMF Shellfish Growing Area N2.0) is prohibited, see Appendix E (DFWELE 2000).

Based on the DMF shellfishing status information, the *Shellfishing Use* is assessed as non-support for this entire segment.

PRIMARY* AND *SECONDARY CONTACT RECREATION

Fecal coliform data for three sampling stations in the Basin in the Merrimack River Estuary were reported by DMF between February 1996 and July 2000. The DMF counts ranged between 2.9 to 1547 cfu/100 mL with a total of 146 samples collected (88 samples were collected during the primary contact recreational season) (Kennedy 2001). Only 3 samples (3%) exceeded 400 cfu/100 ml during the primary contact recreational season. The geometric mean at these sampling stations did not exceed 36 cfu/100 mLs. The data set represents both wet and dry weather sampling conditions.

Based on these data, both the *Primary* and *Secondary Contact Recreational Uses* are assessed as support.

AESTHETICS

The Merrimack River Watershed Council reports that this segment of the Merrimack River is generally aesthetically pleasing (Goodno 2001).

The *Aesthetics Use* is assessed as support.

Merrimack River (MA84A-26) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life*		NOT ASSESSED				
Fish Consumption		NOT ASSESSED				
Shellfishing		NON SUPPORT 0.17 square miles	Pathogens		Septic systems, Unknown	
Primary Contact		SUPPORT				
Secondary Contact		SUPPORT				
Aesthetics		SUPPORT				

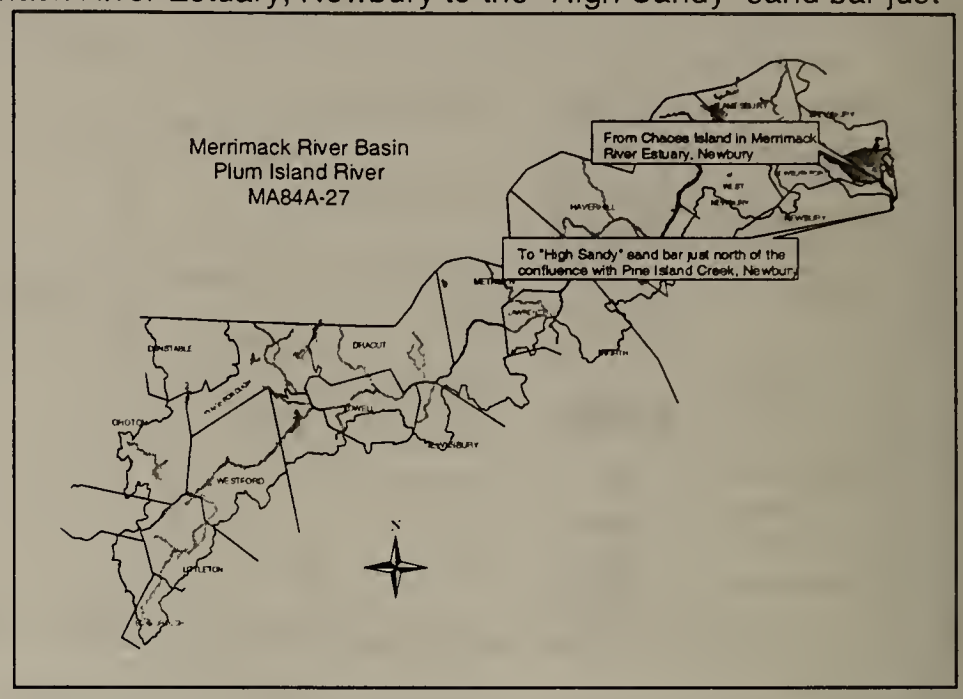
* "alert status" issues identified, details in this segment's USE ASSESSMENT section

RECOMMENDATIONS: MERRIMACK RIVER "THE BASIN" (SEGMENT MA84A-26)

- Conduct additional monitoring (e.g., passive water column PCB samplers as appropriate for estuarine areas, whole fish tissue), to determine the extent, and if necessary, source(s) of PCB contamination.
- Monitor to evaluate/document improvements in water quality conditions as a result of improvements at the Newburyport WPCF and the sewering of Plum Island.

PLUM ISLAND RIVER (SEGMENT MA84A-27)

Location: From Chaces Island in the Merrimack River Estuary, Newbury to the "High Sandy" sand bar just north of the confluence with Pine Island Creek, Newbury.
Size: 0.13 square miles.
Classification: Class SA.


Merrimack River Basin
Plum Island River
MA84A-27
From Chaces Island in Merrimack River Estuary, Newbury
To "High Sandy" sand bar just north of the confluence with Pine Island Creek, Newbury
N

Land-use estimates are not available for this subwatershed area. This segment was listed on the 1998 303(d) list of impaired waters for pathogens (Table 3) (formerly encompassed in segment MA84A-23).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information there are no regulated water withdrawals or surface wastewater discharges in this segment.

USE ASSESSMENT:

SHELLFISHING

The entire 0.13 square mile of this segment of the Plum Island River (Shellfish Growing Area N2.0) is prohibited, see Appendix E (DFWELE 2000).

Based on the DMF shellfishing status information, the *Shellfishing Use* is assessed as non-support for this entire segment.

PRIMARY AND *SECONDARY CONTACT RECREATION*

Fecal coliform data for four sampling stations in this segment of the Plum Island River were reported by DMF between February 1996 and July 2000. The DMF counts ranged between 2.9 to 1587 cfu/100 mL with a total of 257 samples collected (152 samples were collected during the primary contact recreational season) (Kennedy 2001). Only 2 samples (1%) exceeded 400 cfu/100 ml during the primary contact recreational season. The geometric mean at these sampling stations did not exceed 29 cfu/100 mLs. The data set represents both wet and dry weather sampling conditions.

Based on these data, both the *Primary* and *Secondary Contact Recreational Uses* are assessed as support.

AESTHETICS

This segment of the Plum Island River contains a vast expanse of scenic salt marsh (Roach 2001).

The *Aesthetics Use* is assessed as support.

Plum Island River (MA84A-27) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NOT ASSESSED				
Shellfishing		NON SUPPORT 0.13 square miles	Pathogens		Unknown	
Primary Contact		SUPPORT				
Secondary Contact		SUPPORT				
Aesthetics		SUPPORT				

RECOMMENDATIONS: PLUM ISLAND RIVER (SEGMENT MA84A-27)

- Monitor to evaluate/document improvements in water quality conditions as a result of improvements at the Newburyport WPCF and the sewering of Plum Island.

blank page – unnumbered

MERRIMACK RIVER BASIN - LAKE ASSESSMENTS

A total of 96 lakes, ponds or impoundments (the term "lakes" will hereafter be used to include all) have been identified and assigned Pond and Lake Information System (PALIS) code numbers in the Merrimack River Basin (Ackerman 1989 and MA DEP 2001a). The total surface area of the Merrimack River Basin lakes is 4,812 acres. They range in size from one to 555 acres; 70 lakes are less than 50 acres, 16 are greater than 100 acres, and of these, six are greater than 200 acres. This report presents information on 27 of these lakes that are in the WBS database. Sixty-nine lakes which total 1,437 acres are unassessed; they are not currently included as segments in the WBS database.

The 27 lakes assessed in this report represent 3,375 of the 4,812 or 70% of the acreage in the Merrimack River Basin (Figure 9). They lie wholly or partly within 22 of the basin's 24 communities (Figure 9). Ten lakes are designated water supplies (i.e., Class A), which accounted for 61% (or 2,047 acres) of the assessed acreage. Eleven of the lakes assessed are less than 50 acres in total surface area.

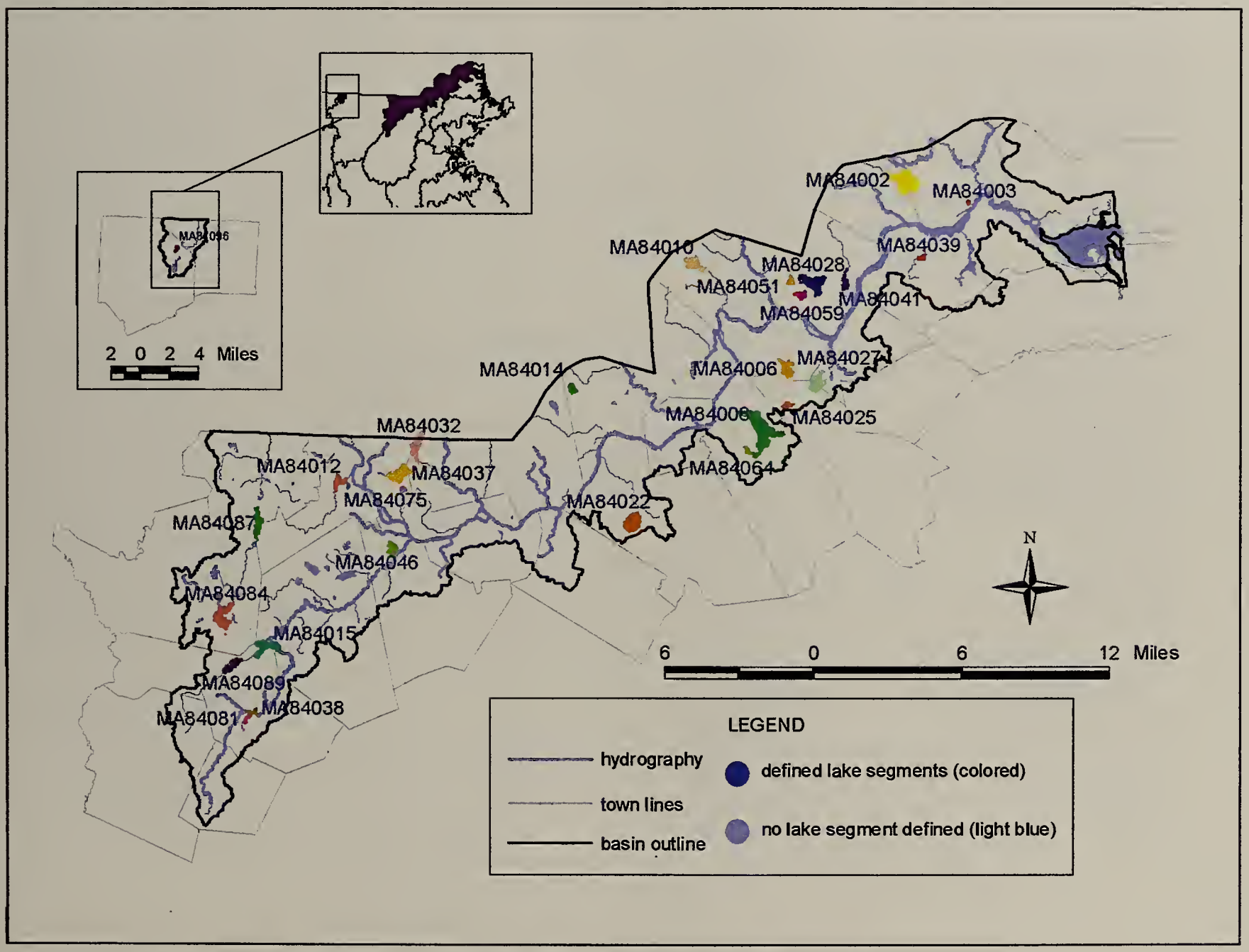


Figure 9. Merrimack River Basin – Lake Segment Locations identified by WBID.

TROPHIC STATUS EVALUATION

Lakes are dynamic ecosystems that over time undergo a process of succession from one trophic state to another. Under natural conditions most lakes move from a nutrient poor (oligotrophic) condition through an intermediate (mesotrophic) stage of nutrient availability and biological productivity to a nutrient-rich or highly productive (eutrophic) state. For the purposes of this report trophic status was estimated primarily using visual observations of macrophyte cover and phytoplankton populations observed in 1994 and/or 1999 by DEP DWM. Occasionally, data from more detailed diagnostic studies were utilized. A more definitive assessment of trophic status would require more extensive collection of water quality and biological data. The trophic status estimates for the lakes assessed in the Merrimack River Basin, are presented in Table 4; six lakes (21% of the assessed lake acreage) were eutrophic and three lakes (3% of the assessed lake acreage) were hypereutrophic. The trophic status was undetermined for 18 lakes (76% of the assessed lake acreage).

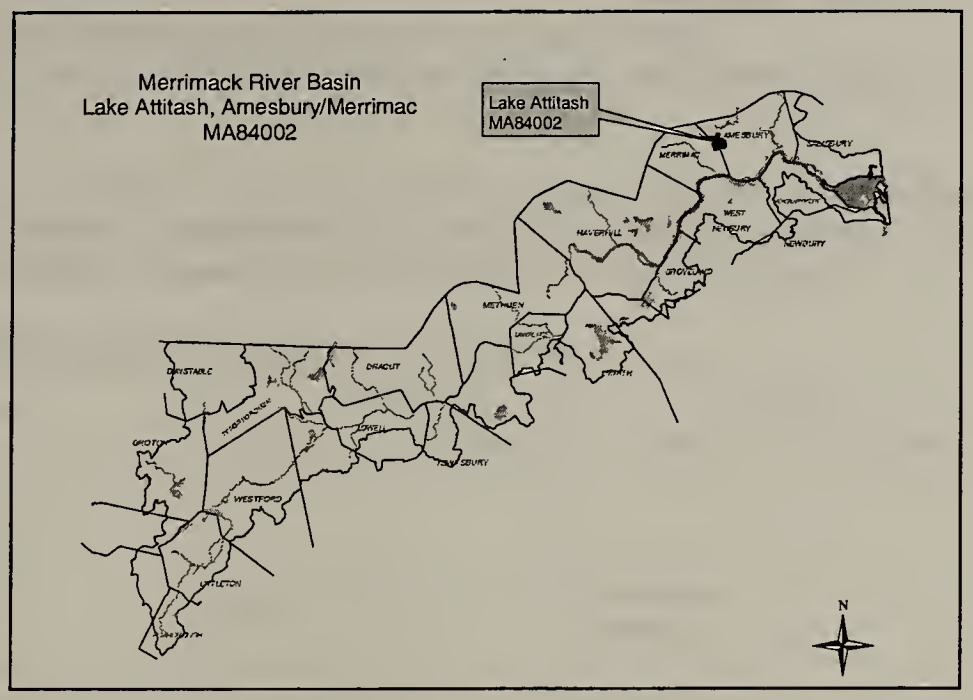
Table 4. Merrimack River Basin lake trophic status estimates (**Bold indicates 1998 303(d) listed**).

Lake	Waterbody Identification Code (WBID)	Class	Size (Acres)	Trophic Status Estimate
Lake Attitash	MA84002	A	360	Undetermined
Bailey Pond	MA84003	B	13	Undetermined
Chadwicks Pond	MA84006	A	161	Undetermined
Lake Cochichewick	MA84008	A	555	Undetermined
Crystal Lake	MA84010	A	165	Undetermined
Flint Pond	MA84012	B	61	Hypereutrophic
Forest Lake	MA84014	B	48	Undetermined
Forge Pond*	MA84015	B	179	Eutrophic
Haggetts Pond	MA84022	A	214	Undetermined
Hoveys Pond	MA84025	A	38	Undetermined
Johnsons Pond	MA84027	A	180	Undetermined
Kenoza Lake	MA84028	A	287	Undetermined
Knops Pond/Lost Lake	MA84084	B	204	Eutrophic
Long Pond	MA84032	B	166	Undetermined
Lake Mascuppic	MA84037	B	209	Undetermined
Massapoag Pond	MA84087	B	113	Eutrophic
Mill Pond	MA84038	B	22	Hypereutrophic
Mill Pond	MA84081	B	12	Hypereutrophic
Mill Pond	MA84039	B	16	Undetermined
Millvale Reservoir	MA84041	A	43	Undetermined
Newfield Pond	MA84046	B	77	Eutrophic
Lake Pentucket	MA84051	A	44	Undetermined
Lake Saltonstall	MA84059	B	45	Undetermined
Spectacle Pond	MA84089	B	79	Eutrophic
Stevens Pond	MA84064	B	26	Undetermined
Uptons Pond	MA84075	B	7	Undetermined
Ward Pond	MA84096	B	51	Eutrophic

* Source of data: Diagnostic/Feasiblilty Study for the Management of Forge Pond (BEC 1987).

LAKE ATTITASH (SEGMENT MA84002)

Location: Amesbury/Merrimac
Size: 360 acres
Classification: Class A, Public Water Supply
Estimated Trophic Status: Undetermined



Lake Attitash, Amesbury/Merrimac is also known as Kimballs Pond. This lake is on the 1998 303(d) list of impaired waters for noxious aquatic plants. A water quality study was conducted in 1977 and 1978 by DEQE staff (Notini and Chagnon 1980). More recently a watershed management plan was completed that reviewed historic information and offered recommendations for reducing pollutant inputs to the lake (CDM 1999).

WMA WATER WITHDRAWAL SUMMARY (TABLE D2):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Merrimac Water Department*	3180000		31318001	01G 02G	0.36**	0.47**

* the Merrimac Water Department is in the process of a registration modification for two new replacement wells for 01 (03G and 04G) which is currently under review by the Department, **the Merrimac Water Department exceeded the WMA registration threshold (>0.1 MGD over their registered volume).

The Drinking Water Program also lists Lake Attitash as an active source for the Amesbury Water Treatment Facility. Lake Attitash flows to the Powwow River where the intake structure is located. The Lake is not, however, a registered source for the Amesbury Water Treatment Facility (Okeefe 2001).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D1):

Merrimac Water Treatment Facility (MAG640030) is authorized to discharge (permit issued October 2001) 0.11 MGD of filter backwash from outfall serial #001 to an unnamed swamp bordering Lake Attitash. This WTF is generally well operated and in compliance with their permit limits (Casella 2001).

USE ASSESSMENT:

AQUATIC LIFE

Recent water quality reported in CDM 1999 suggests that the trophic status of Lake Attitash has deteriorated since the late 1970's. Volunteer monitors identified reduced Secchi disk measurements, increased chlorophyll *a* and increased oxygen depletion in the hypolimnion, however their data does not meet minimum acceptability criteria.

The *Aquatic Life Use* for Lake Attitash is currently not assessed (lack of quality assured data) but is identified with an "Alert Status" based on reports of deteriorating trophic status.

FISH CONSUMPTION

In 1999 fish toxics monitoring, conducted by Normandeau and Associates, in Lake Attitash was conducted as part of the DEP ORS mercury study. Based on the results of this survey, DPH issued a fish consumption advisory due to mercury contamination for Lake Attitash, Amesbury/Merrimac (MDPH 2001a). The advisory recommends the following:

blank page -- unnumbered

1. "Children under 12, pregnant women and nursing mothers should not consume any fish from Lake Attitash."
2. "The general public should not consume large mouth bass from Lake Attitash."
3. "The general public should limit consumption of non-affected fish from Lake Attitash to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 360 acres of Lake Attitash due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Lake Attitash (MA84002) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life*		NOT ASSESSED				
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Drinking Water		The DEP Drinking Water Program maintains current drinking water supply data.				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

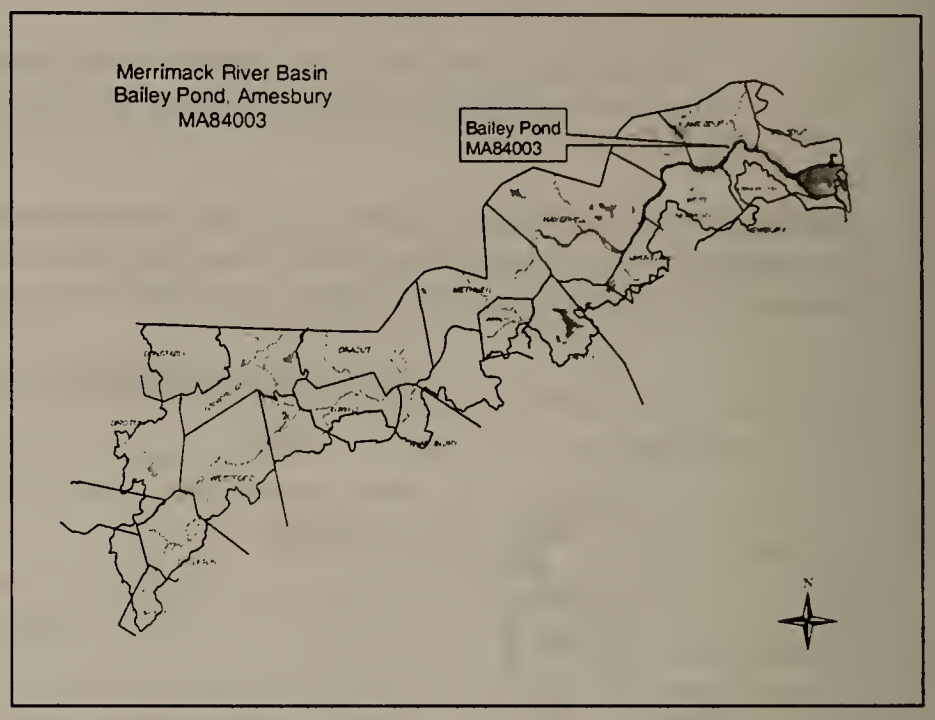
* "Alert Status" issues identified

RECOMMENDATIONS: LAKE ATTITASH (SEGMENT MA84002)

- When the DEP Drinking Water Program SWAP evaluations are completed, review, develop and implement recommendations to protect the Lake Attitash drinking water supply.
- Carefully monitor Merrimac Water Department's compliance with their WMA registration and resolve the need for a registration modification (03 and 04 replacement sources). Resolve registration exceedance as deemed necessary.
- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.
- Review data from "Beaches Bill" required water quality testing at this segment's beach (bacteria sampling from all formal bathing beaches) to assess the status of the recreational uses.
- Review recommendations for long-term restoration/preservation from the Lake Attitash Water Quality Study (Notini and Chagnon 1980) and effect their implementation. Continue to implement recommendations in the Town of Amesbury Lake Attitash Watershed Management Plan (CDM 1999).
- Evaluate the effectiveness of stormwater treatment in the Lake Shore Drive drainage area that discharges into Lake Attitash (Appendix F).

BAILEY POND (SEGMENT MA84003)

Location: Amesbury
Size: 13 acres
Classification: Class B
Estimated Trophic Status: Undetermined



The man-made 13-acre Bailey Pond was used by the Merrimac Hat Corporation between 1856 and 1954 as a water supply for its wet processes (Maietta 1988). A preliminary risk assessment of the pond revealed elevated mercury concentrations in the pond sediments. At the request of the Massachusetts Department of Environmental Quality Engineering (DEQE) (now DEP) Northeast Regional Office (NERO) in October 1986 fish were collected from Bailey Pond in June/July 1987 and the fillets were analyzed for nine metals including mercury (Maietta 1988). With the exception of an individual American eel (*Anguilla rostrata*) whose total mercury concentration was 0.58 mg/kg wet weight, total mercury did not exceed 0.45 mg/kg wet weight in the ten other samples analyzed. No fish consumption advisory was issued.

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:
Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Bailey Pond.

USE ASSESSMENT SUMMARY:
The former Merrimac Hat Factory site was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, list in 1998 (Casella 2001). Elevated mercury concentrations in soils and sediment in and around Bailey Pond are of concern and the Roy F. Weston, Inc. consulting firm has been contracted by the US EPA/MA DEP to provide final remediation at the site which will include addition environmental monitoring. At this time all uses are currently not assessed however they are identified with an "Alert Status".

Bailey Pond (MA84003) Use Summary Table

Aquatic Life*	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

* "Alert Status" issues identified

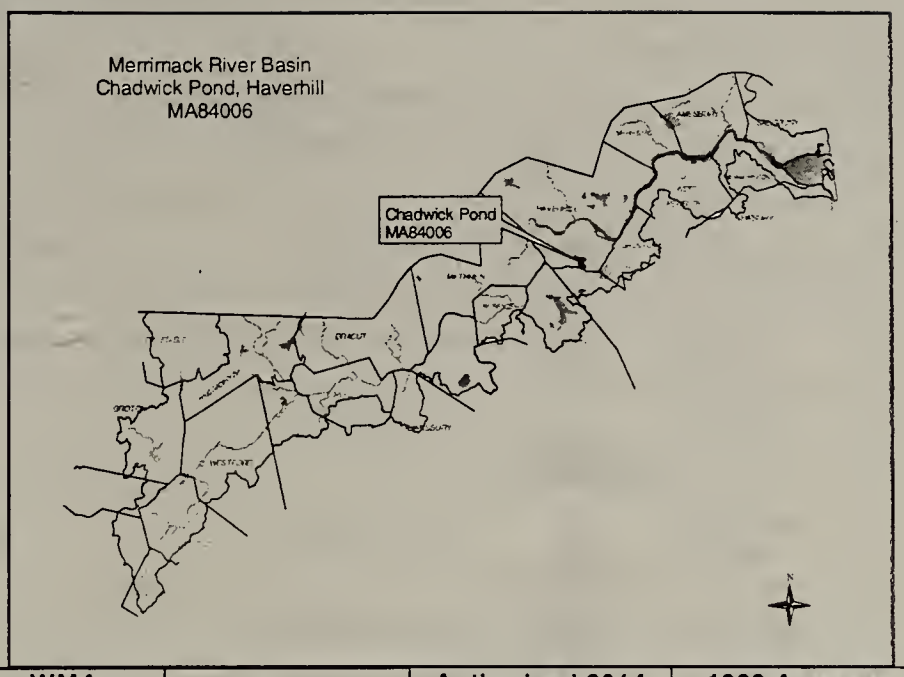
RECOMMENDATIONS: BAILEY POND (SEGMENT MA84003)

- Coordinate monitoring and cleanup efforts with US EPA/MA DEP personnel to collect data to evaluate health/environemental hazards and the effectiveness of the remediation activities.
- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

CHADWICKS POND (SEGMENT MA84006)

Location: Haverhill/Boxford
Size: 161 acres
Classification: Class A, Public Water Supply
Estimated Trophic Status: Undetermined

Chadwicks Pond, Haverhill/Boxford is also known as Little Pond.



WMA WATER WITHDRAWAL SUMMARY (TABLE D2):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Far Corners Farm Golf Course, Inc.		9P231303801		3038012-01G 3038012-02G and 3 irrigation wells and one irrigation pond	0.23	Unavailable (recently issued so no records for 1999)

Chadwicks Pond is an emergency source for the Haverhill Water Treatment Department. The Haverhill Water Treatment Department exceedance is enforcement sensitive; additional technical information has to be submitted to DEP for the pending WMA permit (Casella 2001 and Okeefe 2001).

USE ASSESSMENT:

AQUATIC LIFE

Chemistry-water

On 21 April 1999, a Hydrolab® profile of the deep hole station (approximately 28 feet) in Chadwicks Pond was taken by DWM. These data can be found in Appendix B, Table B3.

The oxygen and saturation levels were above water quality standards throughout the water column however they do not represent worst-case (maximum extent of growing season/summertime) conditions. These data alone are insufficient to project whether or not the *Aquatic Life Use* is impaired. Therefore the *Aquatic Life Use* is not assessed.

FISH CONSUMPTION

In April 1999 fish toxics monitoring was conducted by DWM in Chadwicks Pond as part of the DEP ORS mercury study. These data can be found in Appendix B, Table B5. Because of the elevated levels of mercury, DPH issued a fish consumption advisory for Chadwicks Pond, Haverhill/Boxford (MDPH 2001a). The advisory recommends that:

1. "The general public should not consume any fish from Chadwicks Pond."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 161 acres of Chadwicks Pond due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Chadwicks Pond (MA84006) Use Summary Table

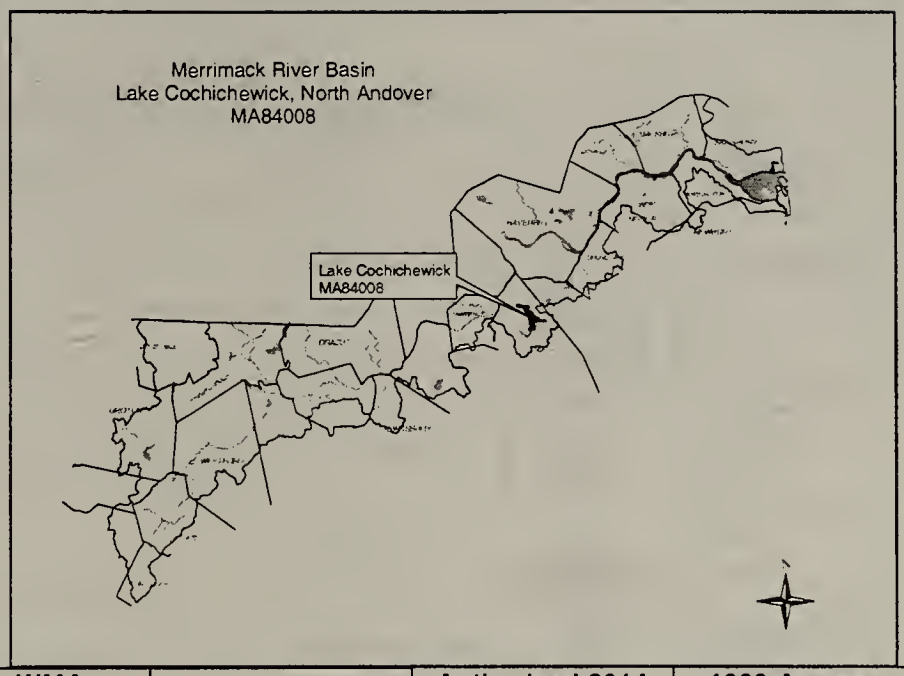
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Drinking Water		The DEP Drinking Water Program maintains current drinking water supply data.				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: CHADWICKS POND (SEGMENT MA84006)

- When the DEP Drinking Water Program SWAP evaluations are completed, review, develop and implement recommendations to protect the Chadwicks Pond drinking water supply.
- As part of the WMA 5-year review, DEP should continue to evaluate Far Corners Farm Golf Course's, Inc. compliance with their WMA permit limit
- Coordinate with groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

LAKE COCHICHEWICK (SEGMENT MA84008)

Location: North Andover
Size: 555 acres
Classification: Class A, Public Water Supply
Estimated Trophic Status: Undetermined



WMA WATER WITHDRAWAL SUMMARY (TABLE D2):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized 2014 Withdrawal (MGD)	1999 Average Withdrawal (MGD)
North Andover Water Department	3210000		31321001	210-02S	2.66	3.38

**the North Andover Water Department exceeded their WMA registration threshold (>0.1 MGD over their registered volume).

The North Andover Water Department exceedance is enforcement sensitive; the North Andover Water Department signed an Administrative Consent Order and has submitted a WMA permit application (Casella 2001 and Okeefe 2001).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D1):
North Andover applied for an NPDES permit (MA0103217) to discharge Emergency Overflow to Lake Cochichwick in 1990.

USE ASSESSMENT:

AQUATIC LIFE

Chemistry-water

On 17 May 1999, a Hydrolab® profile of the deep hole station in Lake Cochichewick was taken by DWM. These data can be found in Appendix B, Table B3.

While the oxygen profile indicated that oxygen depletion was beginning to occur it does not represent worst-case (maximum extent of growing season/summertime) conditions. These data alone are insufficient to project whether or not the *Aquatic Life Use* is impaired. Although the *Aquatic Life Use* is not assessed it is identified with an "Alert Status".

FISH CONSUMPTION

In May 1999 fish toxics monitoring was conducted by DWM in Lake Cochichewick as part of the DEP ORS mercury study. These data can be found in Appendix B, Table B6. Because of the elevated levels of mercury, DPH issued a fish consumption advisory for Lake Cochichewick, North Andover (MDPH 2001a). The advisory recommends that:

1. "Children under 12, pregnant women and nursing mothers should not eat largemouth bass from this waterbody."
2. "The general public should limit consumption of largemouth bass to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 555 acres of Lake Cochichewick due to mercury contamination. It should be noted that a

statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Lake Cochichewick (MA84008) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life*		NOT ASSESSED				
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Drinking Water		The DEP Drinking Water Program maintains current drinking water supply data.				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

*"Alert Status" issues identified

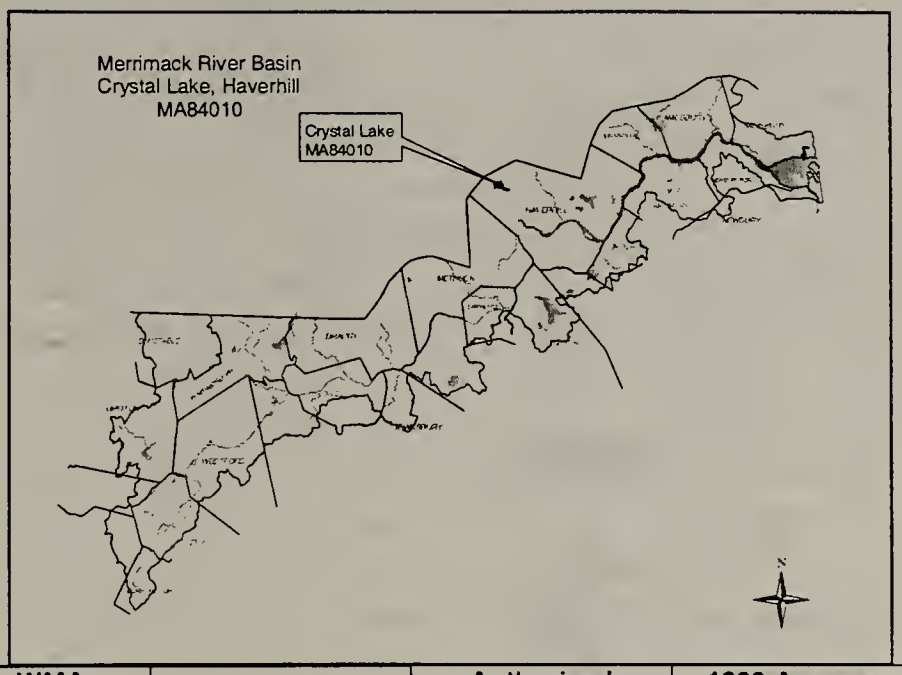
RECOMMENDATIONS: LAKE COCHICHEWICK (SEGMENT MA84008)

- When the DEP Drinking Water Program SWAP evaluations are completed, review, develop and implement recommendations to protect the Lake Cochichewick drinking water supply.
- As part of the WMA 5-year review process, DEP should carefully monitor the North Andover Water Department's WMA withdrawals and proceed with follow-up actions as deemed appropriate.
- Coordinate with groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.
- MA DEP and EPA should develop and issue the Emergency Overflow NPDES permit MA0103217 for North Andover.

CRYSTAL LAKE (SEGMENT MA84010)

Location: Haverhill
Size: 165 acres
Classification: Class A, Public Water Supply
Estimated Trophic Status: Undetermined

Crystal Lake, Haverhill is also known as Creek Pond.



WMA WATER WITHDRAWAL SUMMARY (TABLE D2):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Haverhill Water Treatment Department	3128000		31312802	128-03S	6.06*	6.67*, **

* indicates system-wide withdrawal; all sources are not necessarily within this segment, ** exceeded WMA threshold of >0.1 MGD over registration volume

The Haverhill Water Treatment Department exceedance is enforcement sensitive; additional technical information has to be submitted to DEP for the pending WMA permit (Casella 2001 and Okeefe 2001).

USE ASSESSMENT:

FISH CONSUMPTION

In 1999, fish toxics monitoring, conducted by Normandeau Associates, was conducted in Crystal Lake as part of the DEP ORS mercury study. Because of elevated mercury concentrations, DPH issued a fish consumption advisory due to mercury contamination for Crystal Lake, Haverhill (MDPH 2001a). The advisory recommends the following:

1. "Children under 12, pregnant women and nursing mothers should not consume any fish from Crystal Lake."
2. "The general public should not consume largemouth bass from Crystal Lake."
3. "The general public should limit consumption of non-affected fish from Crystal Lake to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 165 acres of Crystal Lake due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

AESTHETICS

Crystal Lake has been described by the Merrimack River Watershed Team as having high aesthetic quality (Casella 2001).

Based on this information the Aesthetic Use is assessed as support.

Crystal Lake (MA84010) Use Summary Table

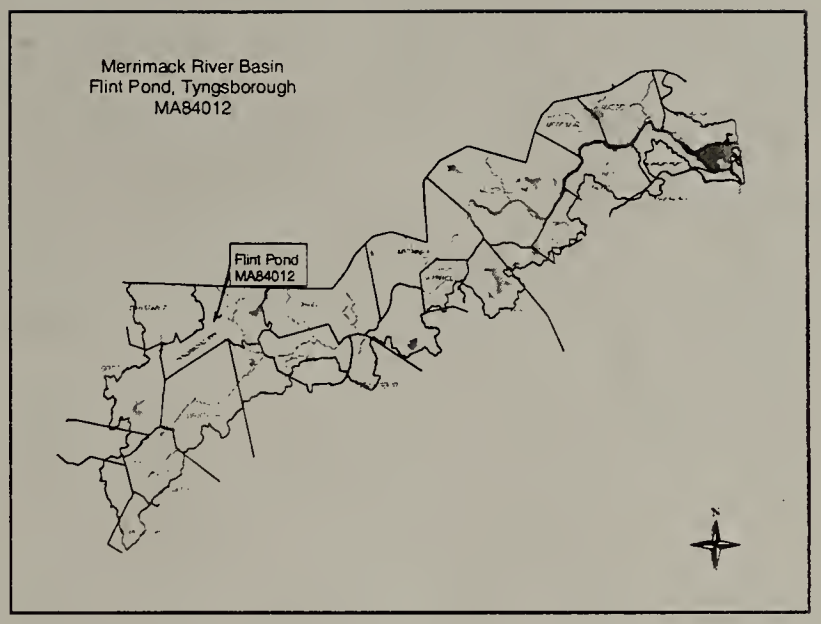
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Drinking Water		The DEP Drinking Water Program maintains current drinking water supply data.				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		SUPPORT				

RECOMMENDATIONS: CRYSTAL LAKE (SEGMENT MA84010)

- When the DEP Drinking Water Program SWAP evaluations are completed, review, develop and implement recommendations to protect the Lake Cochichewick drinking water supply.
- As part of the WMA 5-year review process, DEP should continue to follow up on Haverhill Water Department's WMA exceedance and should take appropriate actions as deemed necessary.
- Coordinate with groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

FLINT POND (SEGMENT MA84012)

Location: Tyngsborough
Size: 61 acres
Classification: Class B
Estimated Trophic Status: Hypereutrophic



This pond is on the 1998 303(d) list of impaired waters for metals and noxious aquatic plants (Table 3). It should also be noted that this pond is located downstream from the Charlie George Landfill in Tyngsborough.

The trophic status estimate is based on DWM's observations of very dense macrophyte cover associated filamentous algae and evidence of diurnal oxygen fluctuations (MA DEP 1999e). The Department is currently drafting a nutrient control TMDL for this waterbody.

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:
Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Flint Pond.

USE ASSESSMENT:

AQUATIC LIFE

Macrophytes

Two non-native macrophytes, *Myriophyllum heterophyllum* (variable milfoil) and *Najas minor* (European naiad) were observed by DWM during the 31 August 1999 macrophyte survey in Flint Pond (Appendix B, Table B2 and MA DEP 1999e).

Chemistry-water

DWM used a Hydrolab® to measure dissolved oxygen, temperature, pH, specific conductivity, and total dissolved solids at the deep hole (1.5m in depth) in July, August and September 1999 Flint Pond. These data can be found in Appendix B, Table B3.

Based on the presence of two non-native macrophytes, the *Aquatic Life Use* is assessed as partial support. While the Hydrolab® data collected in 1999 are insufficient to characterize oxygen dynamics they do point to a highly productive system (supersaturation on a sunny day, 9 September 1999, low saturation on an overcast day, 8 August 1999, and extensive macrophyte cover). It is suspected that diurnal studies would show significant oxygen depletion overnight.

FISH CONSUMPTION

Fish toxics monitoring in Flint Pond was conducted by the Massachusetts DEQE (now DEP) in May 1985. A composite sample of ten white suckers (*Catostomus commersoni*) was analyzed for dioxin and seven heavy metals (Jonash 1986). Subsequent to this survey, additional fish toxics monitoring was conducted in Flint Pond (data reported in the April 1994 Draft Five Year Review for the Charles George Reclamation Landfill prepared for the EPA by Metcalf and Eddy) (Celona 2001).

Based on the data in the Metcalf and Eddy report, DPH issued a fish consumption advisory due to elevated mercury concentrations in Flint Pond, Tyngsborough fish (MDPH 2001a and Celona 2001). The advisory recommends the following:

1. "Children under 12, pregnant women and nursing mothers should not consume any fish from Flint Pond."
2. "The general public should not consume largemouth bass from Flint Pond."
3. "The general public should limit consumption of non-affected fish from Flint Pond to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 61 acres of Flint Pond due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

PRIMARY* AND *SECONDARY CONTACT RECREATION* AND *AESTHETICS

Approximately 50 acres (80%) of Flint Pond were very densely covered with floating leaf and submergent vegetation (Appendix B, Table B2 and MA DEP 1999e). The co-dominant species were *Nymphaea* sp., *Brasenia schreberi*, and *Najas minor*. No algal blooms were observed by DWM during the surveys in July, August, and September 1999. When measured, the Secchi disc transparency was always greater than the four foot (1.2 m) bathing beach criterion (Appendix B, Table B4 and MA DEP 1999e).

Based on the very dense macrophyte cover, the *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses were assessed as non-support for 50 acres. The *Primary Contact Recreational Use* was not assessed for the remaining 11 acres (lack of fecal coliform bacteria data) and the *Secondary Contact Recreational* and *Aesthetics* uses were evaluated as support in the 11 "open-water" acres based on best professional judegment.

Flint Pond (MA84012) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	Exotic species		Unknown	
Fish Consumption		NON-SUPPORT	Mercury		Unknown	
Primary Contact*		NON-SUPPORT 50 acres NOT ASSESSED 11 acres	Noxious aquatic plants		Unknown	
Secondary Contact*		SUPPORT 11 acres NON-SUPPORT 50 acres	Noxious aquatic plants		Unknown	
Aesthetics*		SUPPORT 11 acres NON-SUPPORT 50 acres	Noxious aquatic plants		Unknown	

* "Alert Status" issues identified.

RECOMMENDATIONS: FLINT POND (SEGMENT MA84012)

- Implement recommendations from the nutrient TMDL analysis currently being prepared by DEP.
- Control *M. heterophyllum* and *N. minor* and investigate the downstream spread of these species by implementing the following actions:
  - For exotic aquatic plant species that are isolated to one or a few location(s), quick action is advisable to manage these populations in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from these recorded locations (Table 5), to determine the extent of the infestation. And, "spot" treatments (refer to the draft Generic Environmental Impact Report [GEIR]for Eutrophication and Aquatic Plant Management in Massachusetts [MA DEP and DEM 1998] for advantages and disadvantages) should be undertaken to control populations at these sites before they spread further. These treatments may be in the form of carefully hand-pulling individual plants in small areas. In larger areas, other techniques such as selective herbicide application may be necessary. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These cautions will minimize the spreading of the populations. The draft GEIR (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species.
  - As with the isolated cases, a program to manage the more extensive plant infestations should include additional monitoring efforts to determine the extent of the problem. The draft GEIR for Eutrophication and Aquatic Plant Management in Massachusetts (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic

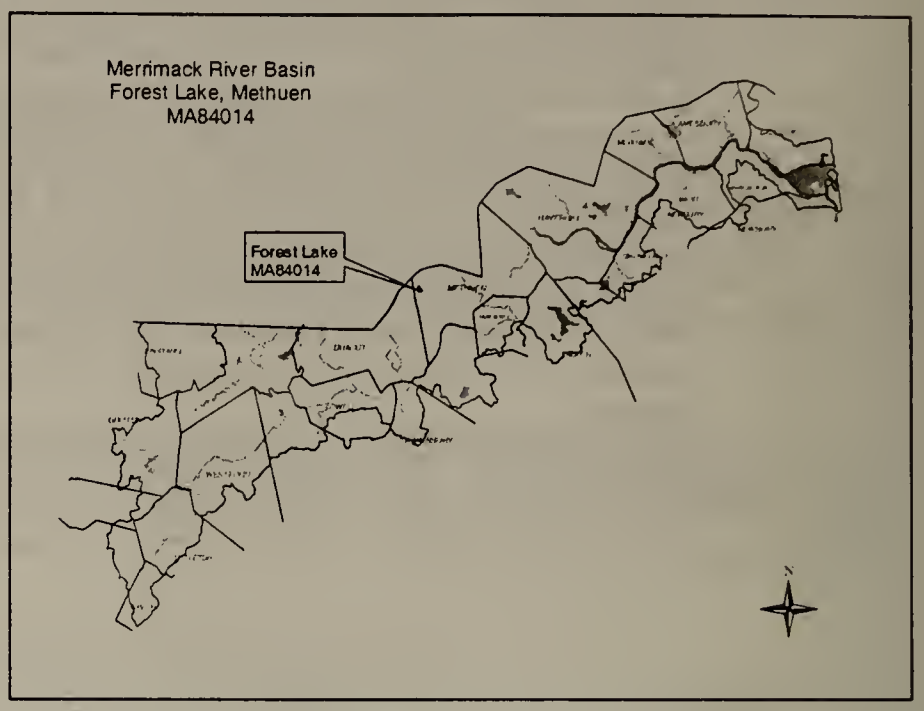
aquatic plant species. Plant control options can be selected from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.) each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should be discouraged because of the propensity for these plants to reproduce and spread vegetatively (from cuttings).

  - Another important component of a management plan is prevention of further spreading of these plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations occurring in unaffected areas (of this pond and to other ponds) and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert pond-users to the problem and responsibility of spreading these species.

- Coordinate with DEM and other groups conducting lake and watershed surveys to generate quality assured lakes data.

FOREST LAKE (SEGMENT MA84014)

Location: Methuen
Size: 48 acres
Classification: Class B, High water quality
Estimated Trophic Status: Undetermined



Forest Lake, Methuen is also known as Harris Pond or South Pond. It is on the 1998 303(d) list of impaired waters for noxious aquatic plants.

A Diagnostic/Feasiblilty Study Forest Lake Methuen was conducted between 1988 and 1989 by Lycott Environmental Research, Inc. (Lycott 1990a).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Forest Lake.

USE ASSESSMENT:

FISH CONSUMPTION

In 1999 fish toxics monitoring was conducted by Normandeau and Associates in Forest Lake as part of the DEP ORS mercury study.

DPH has issued a fish consumption advisory due to mercury contamination for Forest Lake, Methuen (MDPH 2001a).

1. "Children under 12, pregnant women and nursing mothers should not eat largemouth bass from this waterbody."
2. "The general public should limit consumption of largemouth bass to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 48 acres of Forest Lake due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Forest Lake (MA84014) Use Summary Table

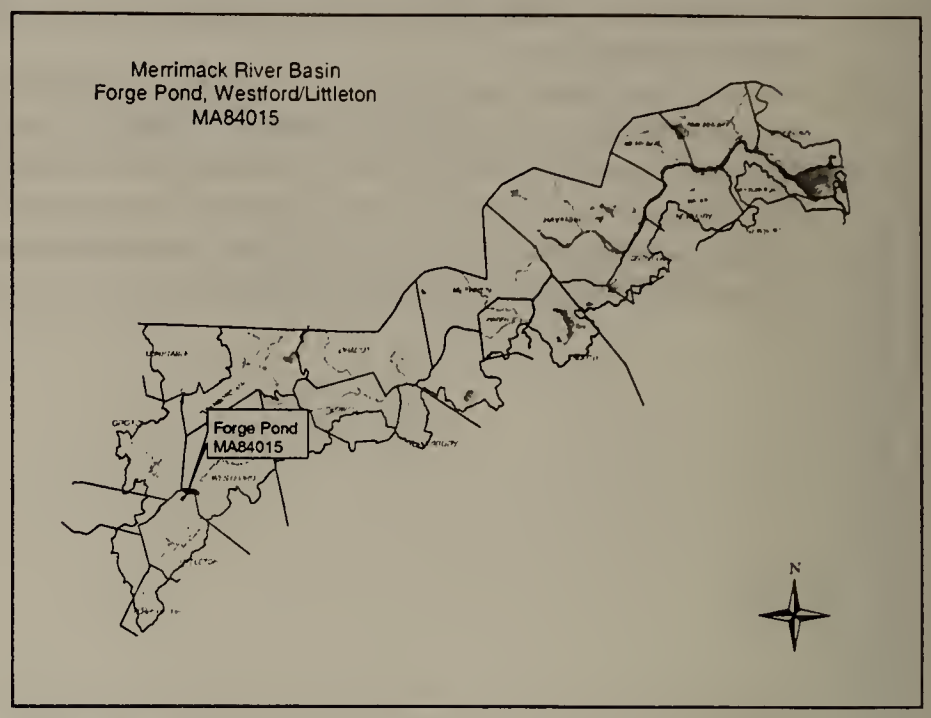
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: FOREST LAKE (SEGMENT MA84014)

- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.
- Review data from "Beaches Bill" required water quality testing at this segment's beach (bacteria sampling from all formal bathing beaches) to assess the status of the recreational uses.
- Review recommendations for long-term restoration/preservation from the Forest Lake Diagnostic Feasibility Study (Lycott 1990a) and effect their implementation.

FORGE POND (SEGMENT MA84015)

Location: Westford/Littleton
Size: 179 acres
Classification: Class B
Estimated Trophic Status: Eutrophic.



A shoreline survey of Forge Pond was carried out by the MRWC and the Lower Stony Brook Stream Team volunteers in April 2000. Results are documented in the Lower Stony Brook Watershed 2000 Shoreline Survey Report (Fullford *et al.* 2000).

A Diagnostic/Feasiblilty Study for the Management of Forge Pond was conducted between May 1985 to April 1986 (BEC 1987).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Forge Pond.

USE ASSESSMENT:

AQUATIC LIFE

In-lake survey information from a diagnostic feasibility study conducted from May 1985 to April 1986 recorded the presence of two non-native macrophytes, *Cabomba caroliniana* (fanwort) and *Potamogeton crispus* (curly-leaf pondweed). However, no recent information is available and therefore the *Aquatic Life Use* is currently not assessed although it is identified with an "Alert Status".

Forge Pond (MA84015) Use Summary Table

Aquatic Life*	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

* "Alert Status" issues identified.

RECOMMENDATIONS: FORGE POND (SEGMENT MA84015)

- Although the shoreline survey of Forge Pond was not conducted during the "worse-case" summer months, recommendations made in the Lower Stony Brook Watershed 2000 Shoreline Survey Report (Fullford *et al.* 2000) should still be implemented.
- Review recommendations for long-term restoration/preservation from the Diagnostic/Feasiblilty Study for the Management of Forge Pond (BEC 1987) and effect their implementation.
- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.
- Review data from "Beaches Bill" required water quality testing at this segment's beach (bacteria sampling from all formal bathing beaches) to assess the status of the recreational uses.
- Control *C. caroliniana* and *P. crispus* and investigate the downstream spread of these species by implelmenting the following actions:
    - For exotic aquatic plant species that are isolated to one or a few location(s), quick action is advisable to manage these populations in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently.

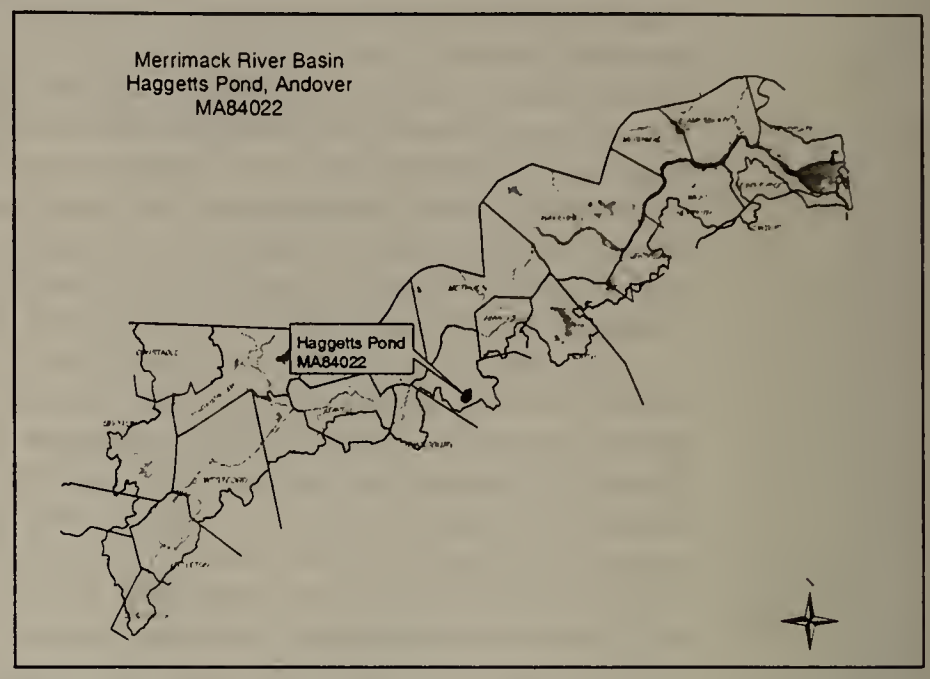
More extensive surveys need to be conducted, particularly downstream from these recorded locations (Table 5), to determine the extent of the infestation. And, "spot" treatments (refer to the draft Generic Environmental Impact Report [GEIR] for Eutrophication and Aquatic Plant Management in Massachusetts [MA DEP and DEM 1998] for advantages and disadvantages) should be undertaken to control populations at these sites before they spread further. These treatments may be in the form of carefully hand-pulling individual plants in small areas. In larger areas, other techniques such as selective herbicide application may be necessary. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These cautions will minimize the spreading of the populations. The draft GEIR (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species.

- As with the isolated cases, a program to manage the more extensive plant infestations should include additional monitoring efforts to determine the extent of the problem. The draft GEIR for Eutrophication and Aquatic Plant Management in Massachusetts (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species. Plant control options can be selected from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.) each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should be discouraged because of the propensity for these plants to reproduce and spread vegetatively (from cuttings).
- Another important component of a management plan is prevention of further spreading of these plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations occurring in unaffected areas (of this pond and to other ponds) and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert pond-users to the problem and responsibility of spreading these species.

HAGGETTS POND (SEGMENT MA84022)

Location: Andover
Size: 214 acres
Classification: Class A, Public Water Supply
Estimated Trophic Status: Undetermined

Haggetts Pond has been described by the Merrimack River Watershed Team as having a large gull population (Casella 2001).



WMA WATER WITHDRAWAL SUMMARY (TABLE D2):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Andover Water Treatment	3009000	9P31300901	31300901	009-01S	8.51*	4.80*

* indicates system-wide withdrawal; all sources are not necessarily within this segment

Water from the Merrimack River is pumped to Haggetts Pond.

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D1):

Andover Water Treatment Plant (MAG640058) is authorized to discharge (permit issued August 2001) 0.8 MGD of filter backwash to Haggetts Pond.

USE ASSESSMENT:

FISH CONSUMPTION

In 1999 fish toxics monitoring, by Normandeau and Associates, was conducted in Haggetts Pond as part of the DEP ORS mercury study. Because of elevated mercury levels, DPH issued a fish consumption advisory for Haggetts Pond, Andover (MDPH 2001a). The advisory recommends the following:

1. "Children under 12, pregnant women and nursing mothers should not eat largemouth bass from Haggetts Pond."
2. "The general public should limit consumption of largemouth bass to two meals per month from Haggetts Pond."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 214 acres of Haggetts Pond due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Haggetts Pond (MA84022) Use Summary Table

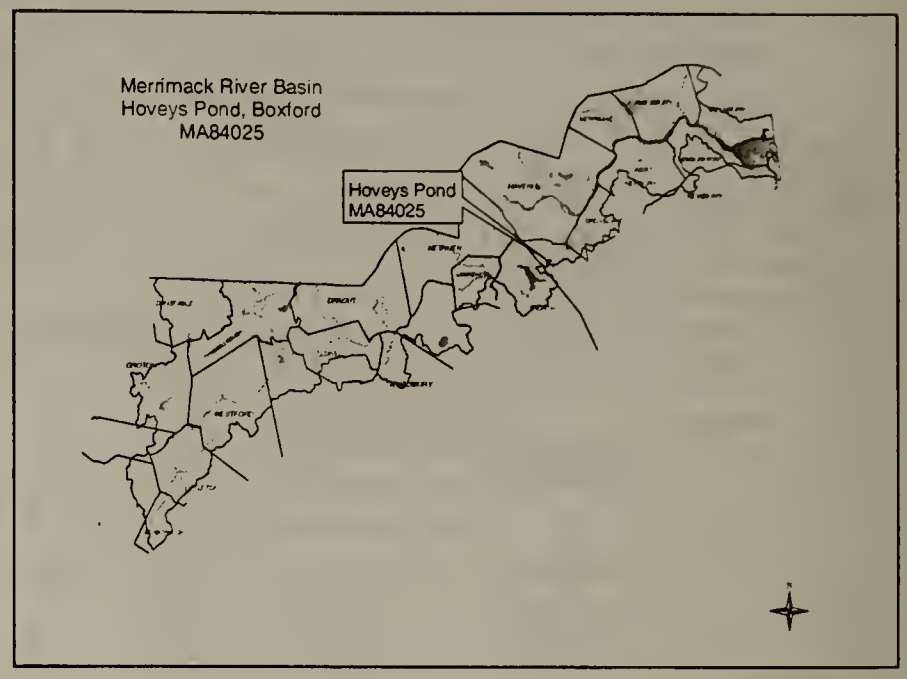
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NON-SUPPORT	Mercury		Atmospheric deposition	
Drinking Water		The DEP Drinking Water Program maintains current drinking water supply data.				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: HAGGETTS POND (SEGMENT MA84022)

- When the DEP Drinking Water Program SWAP evaluations are completed, review, develop and implement recommendations to protect the Haggetts Pond drinking water supply.
- As part of the WMA 5-year review, DEP should continue to evaluate Andover Water Treatment's compliance with WMA registration and/or permit limits.
- Coordinate with groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.
- Implement gull deterent management techniques.

HOVEYS POND (SEGMENT MA84025)

Location: Boxford
Size: 38 acres
Classification: Class A, Public Water Supply
Estimated Trophic Status: Undetermined



WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals or surface wastewater discharges to this waterbody.

Hoveys Pond is an emergency source for the Haverhill Water Treatment Department.

USE ASSESSMENT:

FISH CONSUMPTION

In 1999, fish toxics monitoring, by the City of Haverhill, was conducted in Hoveys Pond as part of the DEP ORS mercury study. Because of elevated mercury concentrations, DPH issued a fish consumption advisory due to mercury contamination for Hoveys Pond, Boxford (MDPH 2001a). The advisory recommends the following:

1. "Children under 12 years, pregnant women and nursing mothers should not consume any fish from Hoveys Pond."
2. "The general public should limit consumption of all fish from Hoveys Pond to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 38 acres of Hoveys Pond due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Hoveys Pond (MA84025) Use Summary Table

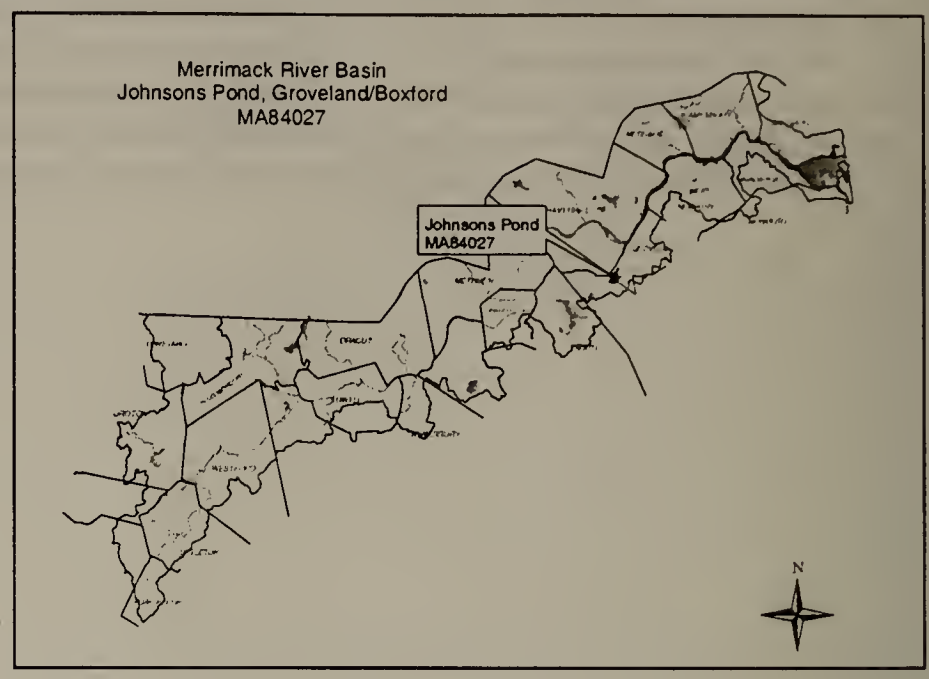
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Drinking Water		The DEP Drinking Water Program maintains current drinking water supply data.				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: HOVEYS POND (MA84025)

- When the DEP Drinking Water Program SWAP evaluations are completed, review, develop and implement recommendations to protect the Hoveys Pond drinking water supply.
- Coordinate with groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

JOHNSONS POND (SEGMENT MA84027)

Location: Groveland/Boxford
Size: 180 acres
Classification: Class A, Public Water Supply
Estimated Trophic Status: Undetermined



WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals or surface wastewater discharges to this waterbody.

USE ASSESSMENT:

AQUATIC LIFE

Chemistry-water

On 6 May 1999, an oxygen profile of the deep hole station (approximately 9 meters – MA DEP 2001c) in Johnsons Pond was measured with a Hydrolab® by DWM. These data can be found in Appendix B, Table B3.

Although the limited data do not represent worst-case (maximum extent of growing season/summertime) conditions, oxygen depletion was evident at 5.9 meters in May 1999. Approximately 50 acres of Johnsons Pond are greater than 5.5 meters (estimated using the bathymetric map - MA DEP 2001c). These 50 acres are considered impaired (partial support) by organic enrichment/low dissolved oxygen.

FISH CONSUMPTION

In May 1999 fish toxics monitoring was conducted by DWM in Johnsons Pond as part of the DEP ORS mercury study. These data can be found in Appendix B, Table B7. Because of elevated mercury concentrations, DPH issued a fish consumption advisory due to mercury contamination for Johnsons Pond, Groveland/Boxford (MDPH 2001a). The advisory recommends the following:

1. "Children under 12, pregnant women and nursing mothers should not eat largemouth bass from Johnsons Pond."
2. "The general public should limit consumption of largemouth bass from Johnsons Pond to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 180 acres of Johnsons Pond due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Johnsons Pond (MA84027) Use Summary Table

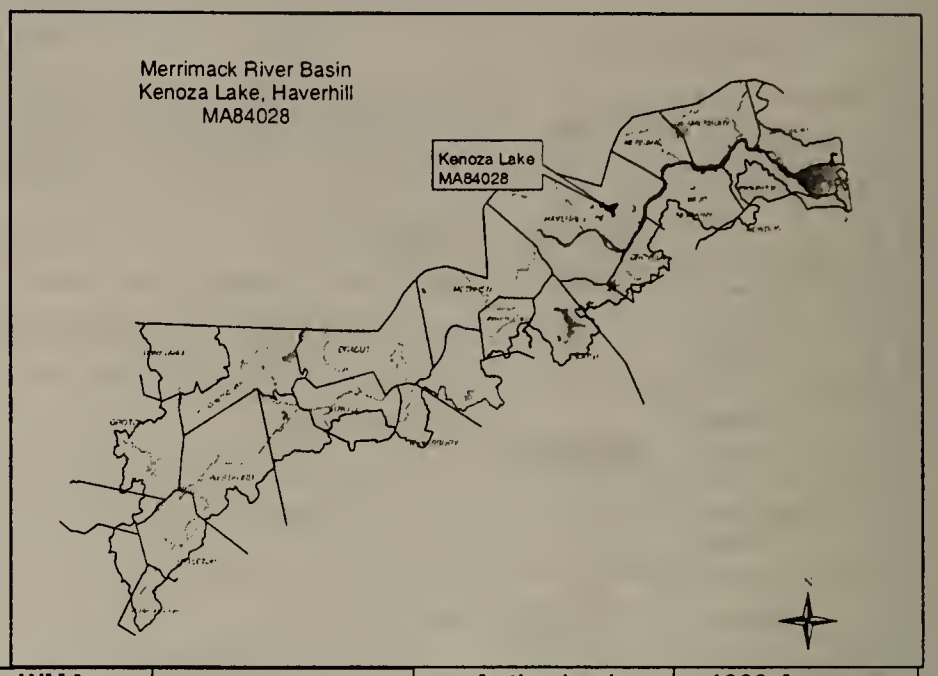
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT 50 acres NOT ASSESSED 130 acres	Organic enrichment/ low DO		Unknown	
Fish Consumption		NON-SUPPORT	Mercury		Atmospheric deposition	
Drinking Water		The DEP Drinking Water Program maintains current drinking water supply data.				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: JOHNSONS POND (SEGMENT MA84027)

- When the DEP Drinking Water Program SWAP evaluations are completed, review, develop and implement recommendations to protect the Johnsons Pond drinking water supply.
- Coordinate with groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

KENOZA LAKE (SEGMENT MA84028)

Location: Haverhill
Size: 287 acres
Classification: Class A, Public Water Supply
Estimated Trophic Status: Undetermined



WMA WATER WITHDRAWAL SUMMARY (TABLE D2):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Haverhill Water Treatment Department	3128000		31312802	128-01S*	6.06*	6.67*, **

* indicates system-wide withdrawal; all sources are not necessarily within this segment, ** exceeded WMA threshold of >0.1 MGD over registration volume

The Haverhill Water Treatment Department exceedance is enforcement sensitive; additional technical information has to be submitted to DEP for the pending WMA permit (Casella 2001 and Okeefe 2001).

USE ASSESSMENT:

FISH CONSUMPTION

In response to a public request, fish toxics monitoring in Kenoza Lake was conducted by DWM in October and December 1998. Elevated levels of mercury in yellow perch (higher than concentrations from most other waterbodies) were documented (Maietta 1999). Because of the elevated mercury concentration DPH issued a fish consumption advisory for Kenoza Lake, Haverhill (MDPH 2001a): Their advisory recommends the following:

1. "The general public should not consume any fish from Kenoza Lake."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 287 acres of Kenoza Lake due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7). Although there is no documented source of mercury in the immediate watershed, local incinerator emissions have been identifies as potential sources. The DEP ORS mercury study was developed in part to investigate the relationship between the proximity of waterbodies to municipal incinerators and fish tissue mercury concentrations (Maietta 1999).

Kenoza Lake (MA84028) Use Summary Table

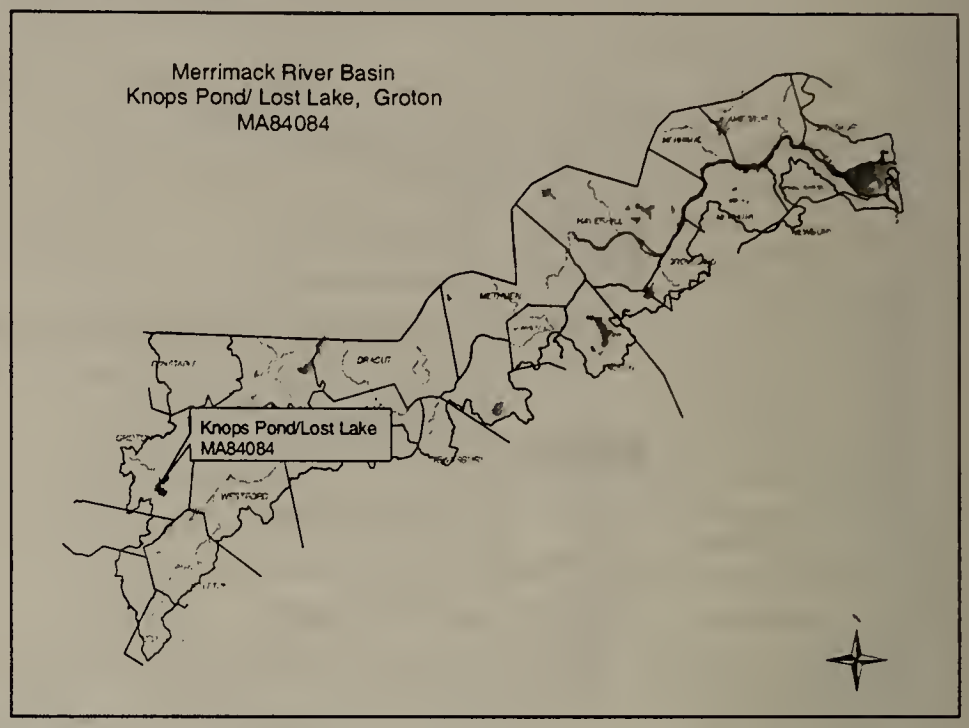
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NON-SUPPORT	Mercury		Atmospheric deposition	
Drinking Water		The DEP Drinking Water Program maintains current drinking water supply data.				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: KENOZA LAKE (SEGMENT MA84028)

- When the DEP Drinking Water Program SWAP evaluations are completed, review, develop and implement recommendations to protect the Kenoza Lake drinking water supply.
- Resolve and issue Haverhill Water Department's WMA permit with appropriate limits and monitoring requirments.
- Coordinate with groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

KNOPS POND/LOST LAKE (SEGMENT MA84084)

Location: Groton
Size: 204 acres
Classification: Class B
Estimated Trophic Status: Eutrophic



This pond is on the 1998 303(d) list of impaired waters for noxious aquatic plants (Table 3).

A Diagnostic/Feasiblilty Study for the Management of Lost Lake/Knopps Pond, Groton, Massachusetts was conducted between October 1987 to September 1988 (BEC 1992).

A survey of Knops Pond/Lost Lake was carried out by the MRWC and the Groton Lakes Association between July and September 1999. Results are documented in the Salmon Brook Watershed – 1999 Shoreline Survey Report (Rapp 1999a).

WMA WATER WITHDRAWAL SUMMARY (TABLE D2):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Groton Water Department	2115000	9P21311501	21311501	115-03G	0.22reg* 0.33per* 0.55total*	0.50*

* indicates system-wide withdrawal; all sources are not necessarily within this segment, ** withdrawal did not exceed registration amount by more than 0.1 MGD (WMA threshold)

This withdrawal is from Whitney Pond Well in the upper watershed of Knops Pond/Lost Lake.

USE ASSESSMENT:

AQUATIC LIFE

In-lake survey information from a diagnostic feasibility study conducted from October 1987 to September 1988 recorded the presence of one non-native macrophyte, *Myriophyllum heterophyllum* (variable milfoil) (BEC 1992). An herbicide license application in 1996 also identified *M. heterophyllum* and *Cabomba caroliniana* in Knops Pond/Lost Lake (MA DEP 2000c).

Because of the presence of non-native macrophytes, the *Aquatic Life Use* for the entire 204 acres of Lost Lake/Knopps Pond is assessed as partial support

Knops Pond/Lost Lake (MA84084) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	Exotic species		Unknown	
Fish Consumption		NOT ASSESSED				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: KNOPS POND/LOST LAKE (SEGMENT MA84084)

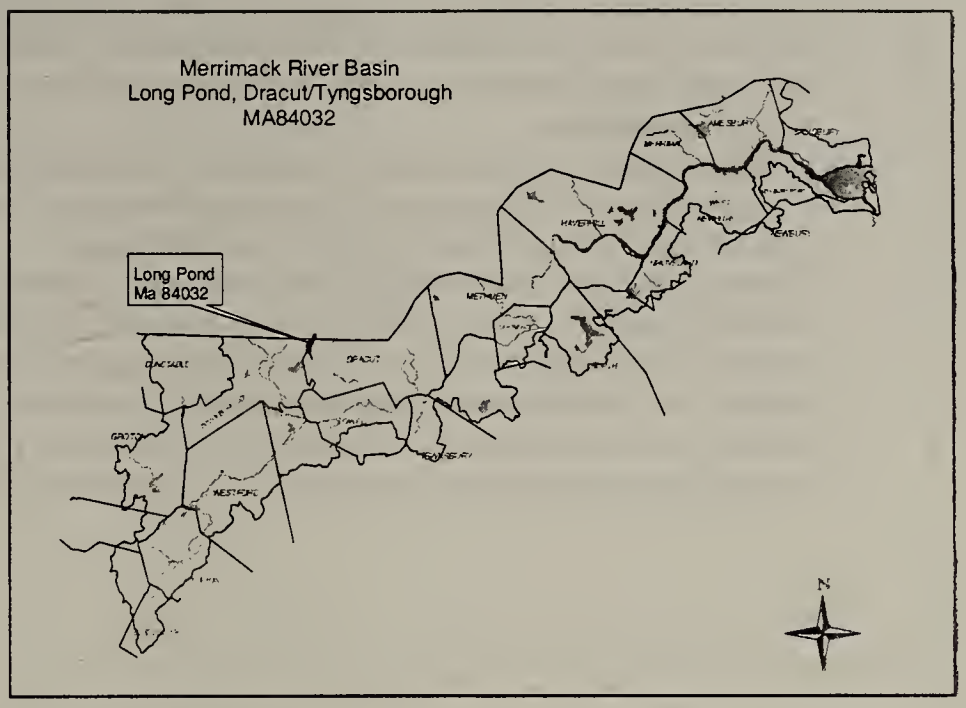
- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.
- Review data from "Beaches Bill" required water quality testing at this segment's beach at this segment's beach (bacteria sampling from all formal bathing beaches) to assess the status of the recreational uses.
- Review recommendations for long-term restoration/preservation from the Knops Pond/Lost Lake Diagnostic Feasibility Study (BEC 1992) and effect their implementation.
- As part of the WMA 5-year review process, DEP should continue to evaluate Groton Water Department's compliance with their WMA registration and/or permit limits.
- Determine the effectiveness of the herbicide treatment on the non-native, aquatic plant infestations. Prevent the further spread of these plants to unaffected areas (of this pond and to other ponds) by alerting pond-users to the problem and responsibility of spreading these exotic species. This should include posting of boat access points with educational warning signs.
- Control *M. heterophyllum* and *C. caroliniana* and investigate the downstream spread of these species by implementing the following actions:
    - For exotic aquatic plant species that are isolated to one or a few location(s), quick action is advisable to manage these populations in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from these recorded locations (Table 5), to determine the extent of the infestation. And, "spot" treatments (refer to the draft Generic Environmental Impact Report [GEIR] for Eutrophication and Aquatic Plant Management in Massachusetts [MA DEP and DEM 1998] for advantages and disadvantages) should be undertaken to control populations at these sites before they spread further. These treatments may be in the form of carefully hand-pulling individual plants in small areas. In larger areas, other techniques such as selective herbicide application may be necessary. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These cautions will minimize the spreading of the populations. The draft GEIR (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species.
    - As with the isolated cases, a program to manage the more extensive plant infestations should include additional monitoring efforts to determine the extent of the problem. The draft GEIR for Eutrophication and Aquatic Plant Management in Massachusetts (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species. Plant control options can be selected from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.) each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation

(such as cutting or raking) should be discouraged because of the propensity for these plants to reproduce and spread vegetatively (from cuttings).

- Another important component of a management plan is prevention of further spreading of these plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations occurring in unaffected areas (of this pond and to other ponds) and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert pond-users to the problem and responsibility of spreading these species.

LONG POND (SEGMENT MA84032)

Location: Dracut/Tyngsborough
Size: 166 acres
Classification: Class B
Estimated Trophic Status: Undetermined



Long Pond, Dracut/Tyngsborough is also known as Lake Passaconaway. It is on the 1998 303(d) list of impaired waters for noxious aquatic plants (Table 3). A Diagnostic/Feasibility Study of Long Pond, Dracut/Tyngsborough, Massachusetts was completed by Lycott Environmental Research, Inc. (Lycott 1989). Long Pond has been treated with herbicides to control nuisance plants and algae for the last several years (MA DEP 2000c). License applications for these treatments have identified the non-native aquatic species *Potamogeton crispus* in Long Pond.

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:
Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Long Pond.

USE ASSESSMENT:

FISH CONSUMPTION

In 1999 fish toxics monitoring, by Normandeau and Associates, was conducted in Long Pond as part of the DEP ORS mercury study. Because of elevated mercury concentrations, DPH issued a fish consumption advisory for Long Pond, Dracut/Tyngsborough (MDPH 2001a). The advisory recommends the following:

1. "Children under 12 years, pregnant women and nursing mothers should not consume any fish from Long Pond."
2. "The general public should limit consumption of all fish from Long Pond to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 166 acres of Long Pond due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Long Pond (MA84032) Use Summary Table

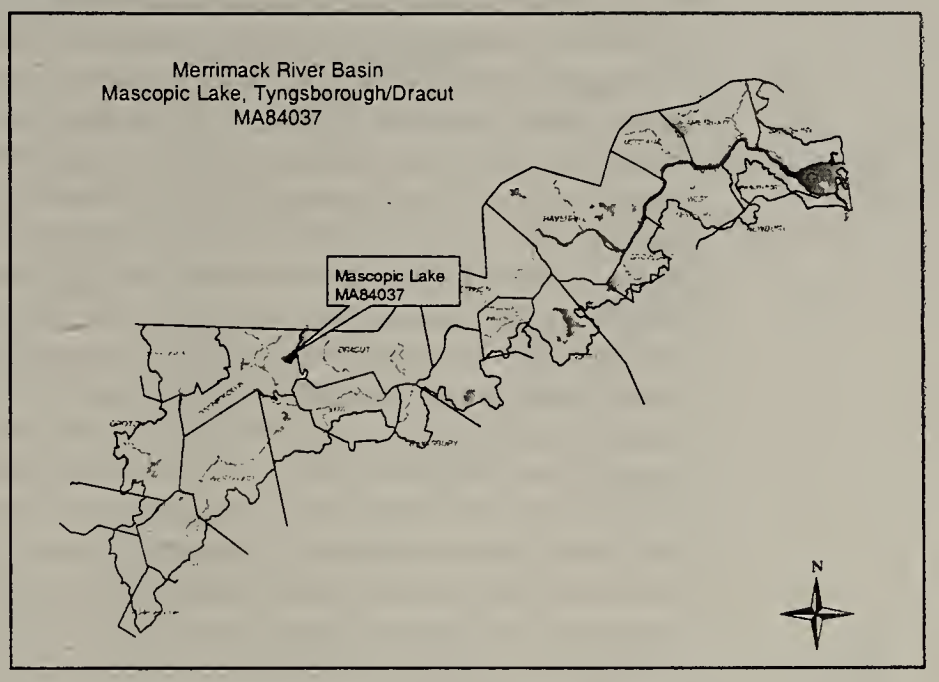
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: LONG POND (SEGMENT MA84032)

- Review recommendations for long-term restoration/preservation from the Long Pond Diagnostic Feasibility Study and effect their implementation (Lycott 1989).
- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species (and confirmation of *Potamogeton crispus*) and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.
- Review data from "Beaches Bill" required water quality testing at this segment's beach (bacteria sampling from all formal bathing beaches) to assess the status of the recreational uses.
- Determine the effectiveness of the herbicide treatment on the non-native, aquatic plant infestations. Prevent the further spread of these plants to unaffected areas (of this pond and to other ponds) by alerting pond-users to the problem and responsibility of spreading these exotic species. This should include posting of boat access points with educational warning signs.

LAKE MASCUPPIC (SEGMENT MA84037)

Location: Tyngsborough/Dracut
Size: 209 acres
Classification: Class B
Estimated Trophic Status:



Lake Mascuppic is also known as Mascopic Lake and Tyngs Pond. A Diagnostic/Feasibility Study of Lake Mascuppic, Dracut/Tyngsborough, Massachusetts was completed by Lycott Environmental Research, Inc. (Lycott 1990b).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Lake Mascuppic.

USE ASSESSMENT SUMMARY:

Historical records identified two non-native aquatic species, *C. caroliniana* and *P. crispus*, present in Lake Mascuppic. Recent herbicide license applications also indicated the presence of *C. caroliniana* (MA DEP 2000c). However, no recent data are available to confirm the presence of these species, and therefore the *Aquatic Life Use* is identified with an "Alert Status".

Lake Mascuppic (MA84037) Use Summary Table

Aquatic Life*	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

*"Alert Status" issues identified.

RECOMMENDATIONS: LAKE MASCUPPIC (SEGMENT MA84037)

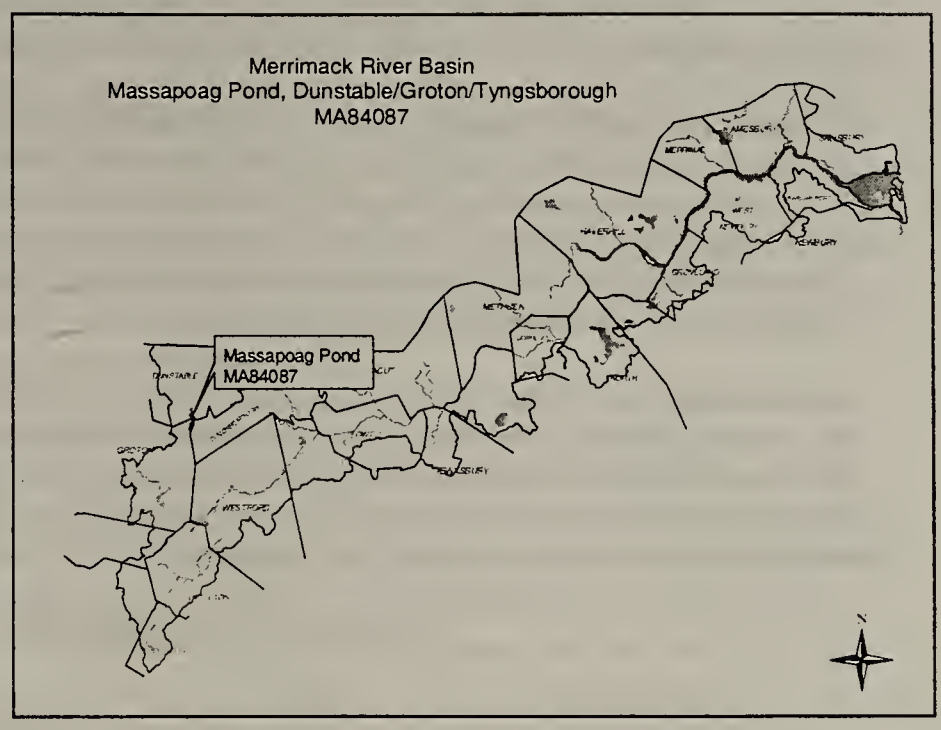
- Review recommendations for long-term restoration/preservation from the Lake Mascuppic Diagnostic Feasibility Study and effect their implementation (Lycott 1990b).
- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species (and confirmation of *C. caroliniana* and *P. crispus*) and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.
- Review data from "Beaches Bill" required water quality testing at this segment's beach (bacteria sampling from all formal bathing beaches) to assess the status of the recreational uses.
- Determine the effectiveness of the herbicide treatment on the non-native, aquatic plant infestations. Prevent the further spread of these plants to unaffected areas (of this pond and to other ponds) by alerting pond-users to the problem and responsibility of spreading these exotic species. This should include posting of boat access points with educational warning signs.
- Control *C. caroliniana* and *P. crispus* and investigate the downstream spread of these species by implementing the following actions:
    - For exotic aquatic plant species that are isolated to one or a few location(s), quick action is advisable to manage these populations in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from these recorded locations (Table 5), to determine the extent of the infestation. And, "spot" treatments (refer to

the draft Generic Environmental Impact Report [GEIR] for Eutrophication and Aquatic Plant Management in Massachusetts [MA DEP and DEM 1998] for advantages and disadvantages) should be undertaken to control populations at these sites before they spread further. These treatments may be in the form of carefully hand-pulling individual plants in small areas. In larger areas, other techniques such as selective herbicide application may be necessary. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These cautions will minimize the spreading of the populations. The draft GEIR (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species.

- As with the isolated cases, a program to manage the more extensive plant infestations should include additional monitoring efforts to determine the extent of the problem. The draft GEIR for Eutrophication and Aquatic Plant Management in Massachusetts (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species. Plant control options can be selected from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.) each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should be discouraged because of the propensity for these plants to reproduce and spread vegetatively (from cuttings).
- Another important component of a management plan is prevention of further spreading of these plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations occurring in unaffected areas (of this pond and to other ponds) and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert pond-users to the problem and responsibility of spreading these species.

MASSAPOAG POND (SEGMENT MA84087)

Location: Dunstable/Groton/Tyngsborough
Size: 113 acres
Classification: Class B
Estimated Trophic Status: Eutrophic



Massapoag Pond is on the 1998 303(d) list of impaired waters for organic enrichment/low DO (Table 3). The Department is currently drafting a nutrient control TMDL for this waterbody.

A survey of Massapoag Pond was carried out by the MRWC and the Dunstable Stream Team between July and September 1999. Results are documented in the Salmon Brook Watershed – 1999 Shoreline Survey Report (Rapp 1999a).

The trophic status estimate is based on DWM's observations of very dense macrophyte cover and observations of hypolimnetic oxygen depletion (MA DEP 1999e).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:
Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Massapoag Pond.

USE ASSESSMENT:
AQUATIC LIFE

Macrophytes

Two non-native macrophytes, *Myriophyllum heterophyllum* (variable milfoil) and *Potamogeton crispus* (curly-leaf pondweed) were observed by DWM during the 2 September 1999 macrophyte survey in Massapoag Pond (Appendix B, Table B2 and MA DEP 1999e).

Chemistry-water

DWM used a Hydrolab® to measure dissolved oxygen, temperature, pH, specific conductivity, and total dissolved solids at the deep hole (approximately 12.5 m) in Massapoag Pond. These data can be found in Appendix B, Table B3.

Because of the presence of non-native macrophytes, the *Aquatic Life Use* for the entire 113 acres of Massapoag Pond is assessed as partial support. Additionally, oxygen depletion occurred below 4.5 m during July, August, and September 1999. Approximately 20 acres of Massapoag Pond is greater than 4.5 m (estimated using the bathymetric map and MassGIS). In addition to exotic species, the *Aquatic Life Use* for these 20 acres is also assessed as impaired (partial support) by organic enrichment/low dissolved oxygen.

FISH CONSUMPTION

In 1999 fish toxics monitoring, by Normandeau and Associates, was conducted in Massapoag Pond as part of the DEP ORS mercury study. Because of elevated mercury concentrations, DPH issued a fish consumption advisory for Massapoag Pond, Dunstable/Groton/Tyngsborough (MDPH 2001a). The advisory recommends the following:

1. "Children under 12, pregnant women and nursing mothers should not consume any fish from Massapoag Pond."
2. "The general public should limit consumption of all fish from Massapoag Pond to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 113 acres of Massapoag Pond due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

PRIMARY* AND *SECONDARY CONTACT RECREATION* AND *AESTHETICS

Approximately 60 acres of Massapoag Pond were very densely covered with floating leaf and submergent vegetation (Appendix B, Table B2 and MA DEP 1999e). The dominant species was *Potamogeton robbinsii.* No algal blooms were observed by DWM during the surveys in July, August, and September 1999. The Secchi disc transparency was always observed as greater than the four foot (1.2 m) bathing beach criterion (Appendix B, Table B4 and MA DEP 1999e).

Based on the very dense macrophyte cover along the shoreline of Massapoag Pond, the *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses were assessed as non-support for 60 acres. The *Primary Contact Recreational Use* was not assessed for the remaining 53 acres (lack of fecal coliform bacteria data) and the *Secondary Contact Recreational* and *Aesthetics* uses were evaluated as support in the 53 "open-water" acres based on best professional judegment.

Massapoag Pond (MA84087) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	Exotic species, Organic enrichment/low DO		Unknown	
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Primary Contact		NON SUPPORT – 60 acres NOT ASSESSED – 53 acres	Noxious aquatic plants		Unknown	
Secondary Contact		SUPPORT – 53 acres NON SUPPORT – 60 acres	Noxious aquatic plants		Unknown	
Aesthetics		SUPPORT – 53 acres NON SUPPORT – 60 acres	Noxious aquatic plants		Unknown	

RECOMMENDATIONS: MASSAPOAG POND (SEGMENT MA84087)

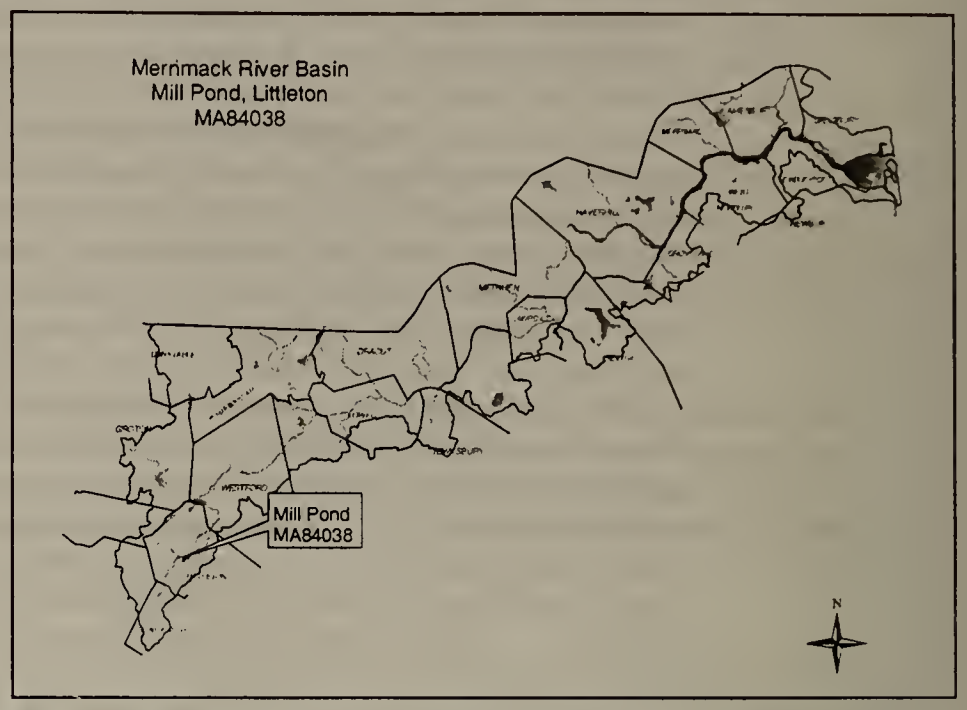
- Implement recommendations from the nutrient TMDL analysis currently being prepared by DEP.
- Support the Dunstable Stream Team action priorities documented in the Salmon Brook Watershed – 1999 Shoreline Survey Report (Rapp 1999a).
- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- Control *M. heterophyllum* and *P. crispus* and investigate the downstream spread of these species by implementing the following actions:
    - For exotic aquatic plant species that are isolated to one or a few location(s), quick action is advisable to manage these populations in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from these recorded locations (Table 5), to determine the extent of the infestation. And, "spot" treatments (refer to the draft Generic Environmental Impact Report [GEIR] for Eutrophication and Aquatic Plant Management in Massachusetts [MA DEP and DEM 1998] for advantages and disadvantages) should be undertaken to control populations at these sites before they spread further. These treatments may be in the form of carefully hand-pulling individual plants in small areas. In larger areas, other techniques such as selective herbicide application may be necessary. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These cautions will minimize the spreading of the

populations. The draft GEIR (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species.

- As with the isolated cases, a program to manage the more extensive plant infestations should include additional monitoring efforts to determine the extent of the problem. The draft GEIR for Eutrophication and Aquatic Plant Management in Massachusetts (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species. Plant control options can be selected from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.) each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should be discouraged because of the propensity for these plants to reproduce and spread vegetatively (from cuttings).
- Another important component of a management plan is prevention of further spreading of these plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations occurring in unaffected areas (of this pond and to other ponds) and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert pond-users to the problem and responsibility of spreading these species.

MILL POND (SEGMENT MA84038)

Location: Littleton
Size: 22 acres
Classification: Class B
Estimated Trophic Status: Hypereutrophic



This pond (the North Basin) is on the 1998 303(d) list of impaired waters for noxious aquatic plants (Table 3). The US ACOE is preparing a preliminary restoration proposal for this pond (Blumeris 2001b).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals from or surface wastewater discharges directly to Mill Pond. It should be noted however that Veryfine Products, Inc. discharges to an unnamed tributary of Mill Pond (see information on page 38: river segment MA84B-01).

USE ASSESSMENT SUMMARY:

No current data/information was available therefore all uses are currently not assessed.

Mill Pond (MA84038) Use Summary Table

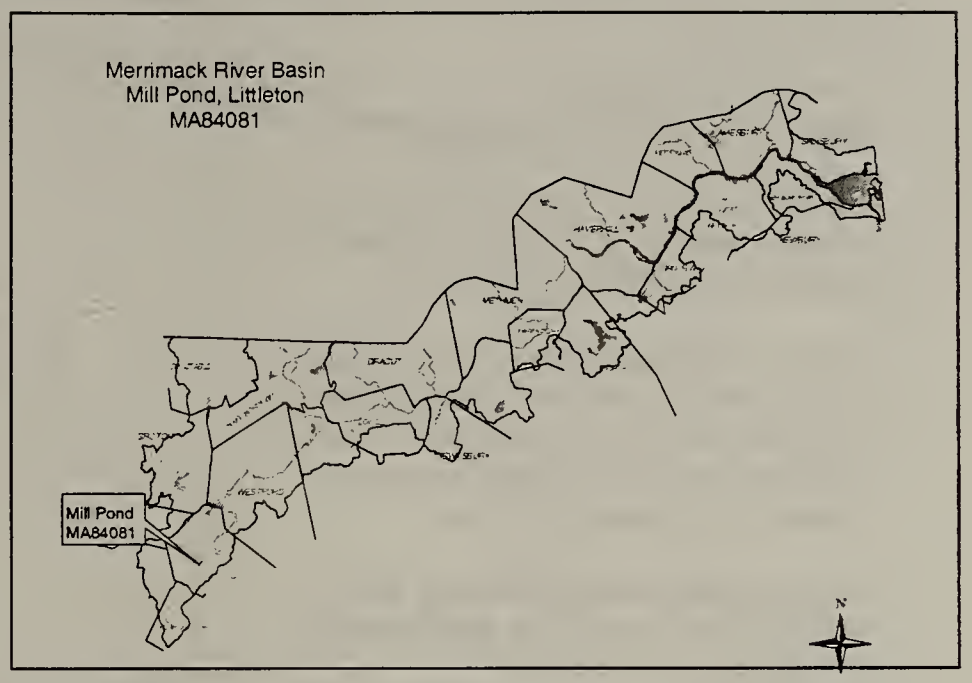
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: MILL POND (SEGMENT MA84038)

- Review the US ACOE restoration proposal for this pond when available.
- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

MILL POND (SEGMENT MA84081)

Location: Littleton
Size: 12 acres
Classification: Class B
Estimated Trophic Status: Hypereutrophic



This pond is on the 1998 303(d) list of impaired waters for noxious aquatic plants. It is the southern basin of Mill Pond (Segment MA84038) (Table 3) . The US ACOE is preparing a preliminary restoration proposal for this pond (Blumeris 2001b).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Mill Pond.

USE ASSESSMENT SUMMARY:

No current data/information was available therefore all uses are currently not assessed.

Mill Pond (MA84081) Use Summary Table

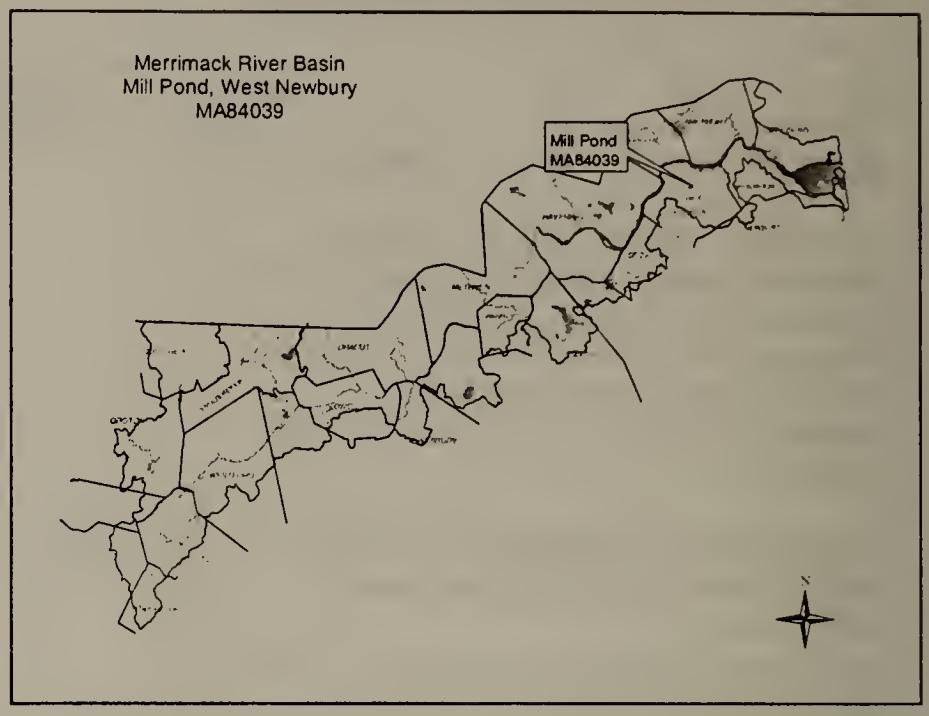
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: MILL POND (SEGMENT MA84081)

- Review the US ACOE restoration proposal for this pond when available.
- Coordinate with DEM and/or other groups conducting lake surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

MILL POND (SEGMENT MA84039)

Location: West Newbury
Size: 16 acres
Classification: Class B
Estimated Trophic Status: Undetermined



This pond is on the 1998 303(d) list of impaired waters for nutrients, siltation, and noxious aquatic plants (Table 3).

A Mill Pond Diagnostic/Feasiblilty Study West Newbury was conducted between April 1986 and March 1987 (IEP 1988). Dredging of the pond was completed in October 2000 (Barber 2001a).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Mill Pond.

USE ASSESSMENT SUMMARY:

No current data/information was available therefore all uses are currently not assessed.

Mill Pond (MA84039) Use Summary Table

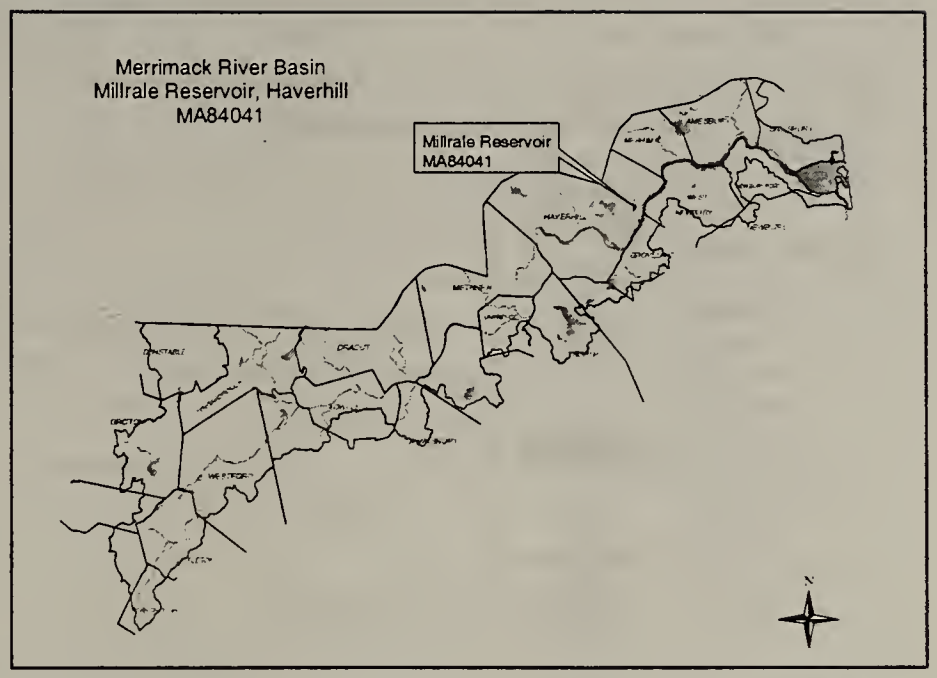
Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: MILL POND (SEGMENT MA84039)

- Review recommendations for long-term restoration/preservation from the Mill Pond Diagnostic Feasibility Study (IEP 1988) and effect their implementation.
- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

MILLVALE RESERVOIR (SEGMENT MA84041)

Location: Haverhill
Size: 43 acres
Classification: Class A, Public Water Supply
Estimated Trophic Status: Undetermined



WMA WATER WITHDRAWAL SUMMARY (TABLE D2):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Haverhill Water Treatment Department	3128000		31312802	128-05S*	6.06*	6.67*, **

* indicates system-wide withdrawal; all sources are not necessarily within this segment, ** exceeded WMA threshold of >0.1 MGD over registration volume

The Haverhill Water Treatment Department exceedance is enforcement sensitive; additional technical information has to be submitted to DEP for the pending WMA permit (Casella 2001 and Okeefe 2001).

USE ASSESSMENT:

FISH CONSUMPTION

In 1999 fish toxics monitoring, by the City of Haverhill, was conducted in Millvale Reservoir as part of the DEP ORS mercury study. Because of elevated mercury concentrations, DPH issued a fish consumption advisory for Millvale Reservoir, Haverhill (MDPH 2001a). The advisory recommends the following:

1. "Children under 12, pregnant women and nursing mothers should not consume any fish from Millvale Reservoir."
2. "The general public should not consume any largemouth bass from Millvale Reservoir."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 43 acres of Millvale Reservoir due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Millvale Reservoir (MA84041) Use Summary Table

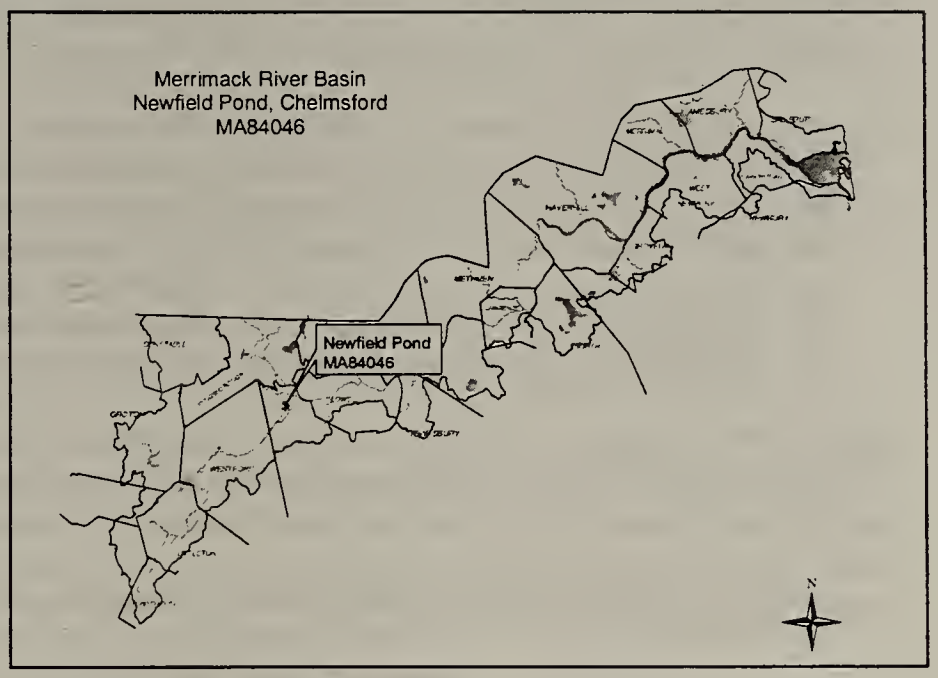
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Drinking Water		The DEP Drinking Water Program maintains current drinking water supply data.				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: MILLVALE RESERVOIR (SEGMENT MA84041)

- When the DEP Drinking Water Program SWAP evaluations are completed, review, develop and implement recommendations to protect the Millvale Reservoir drinking water supply.
- Resolve and issue Haverhill Water Department's WMA permit with appropriate limits and monitoring requirments.
- Coordinate with groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

NEWFIELD POND (SEGMENT MA84046)

Location: Chelmsford
Size: 77 acres
Classification: Class B
Estimated Trophic Status: Eutrophic



Newfield Pond is also known as Freeman Lake or Crystal Lake. This pond is on the 1998 303(d) list of impaired waters for organic enrichment/ low DO (Table 3). The Department is currently drafting a nutrient control TMDL for this waterbody.

The trophic status estimate is based on DWM's observations of very dense macrophyte cover, evidence of hypolimnetic oxygen depletion and supersaturation of oxygen in the epilimnion (MA DEP 1999e).

It should also be noted that Chelmsford has received SRF funding to implement their Long Term plan to eliminate Title V systems and install sewers in the community (Barber 2001a).

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:
Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Newfield Pond.

USE ASSESSMENT:

AQUATIC LIFE

Macrophytes

Three non-native macrophytes, *Cabomba caroliniana* (fanwort), *Myriophyllum spicatum* (Eurasian milfoil) and *Potamogeton crispus* (curly-leaf pondweed) were observed by DWM during the 23 August 1999 macrophyte survey in Newfield Pond (Appendix B, Table B2 and MA DEP 1999e).

Chemistry-water

DWM used a Hydrolab® to measure dissolved oxygen, temperature, pH, specific conductivity, and total dissolved solids at the deep hole (approximately 8.2 m) in Newfield Pond. These data can be found in Appendix B, Table B3.

Because of the presence of non-native macrophytes, the *Aquatic Life Use* for the entire 77 acres of Newfield Pond is assessed as partial support. Additionally, oxygen depletion occurred below four meters during July, August, and September 1999. Approximately seven acres of Newfield Pond is greater than four meters (estimated using the bathymetric map and GIS). In addition to exotic species, the *Aquatic Life Use* for these seven acres is also assessed as impaired (partial support) by organic enrichment/low dissolved oxygen.

FISH CONSUMPTION

In 1999 fish toxics monitoring, by Normandeau and Associates, was conducted in Newfield Pond as part of the DEP ORS mercury study. Because of elevated mercury concentrations, DPH issued a fish consumption advisory for Newfield Pond, Chelmsford (MDPH 2001a). The advisory recommends the following:

1. "Children under 12, pregnant women and nursing mothers should not eat largemouth bass from Newfield Pond."
2. "The general public should limit consumption of largemouth bass from Newfield Pond to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 77acres of Newfield Pond due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

PRIMARY* AND *SECONDARY CONTACT RECREATION* AND *AESTHETICS

Approximately 27 acres, primarily along the western portion of Newfield Pond, were densely to very densely covered with submergent vegetation (Appendix B, Table B2 and MA DEP 1999e). The dominant species was *M. spicatum*. Although no algal blooms were observed by DWM during the surveys in July, August, and September 1999 there was evidence of nuisance blue-green species (*Microcystis* sp.). The Secchi disc transparency was always observed as greater than the four foot (1.2 m) bathing beach criterion (Appendix B, Table B4 and MA DEP 1999e).

Based on the dense/very dense macrophyte cover along the western portion of Newfield Pond, the *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses were assessed as non-support for 27 acres. The *Primary Contact Recreational Use* was not assessed for the remaining 50 acres (lack of fecal coliform bacteria data) and the *Secondary Contact Recreational* and *Aesthetics* uses were evaluated as support in the 50 "open-water" acres based on best professional judegment.

Newfield Pond (MA84046) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	Exotic species, Organic enrichment/low DO		Unknown	
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Primary Contact		NON SUPPORT – 27 acres NOT ASSESSED – 50 acres	Noxious aquatic plants		Unknown	
Secondary Contact		SUPPORT – 50 acres NON SUPPORT – 27 acres	Noxious aquatic plants		Unknown	
Aesthetics		SUPPORT – 50 acres NON SUPPORT – 27 acres	Noxious aquatic plants		Unknown	

RECOMMENDATIONS: NEWFIELD POND (SEGMENT MA84046)

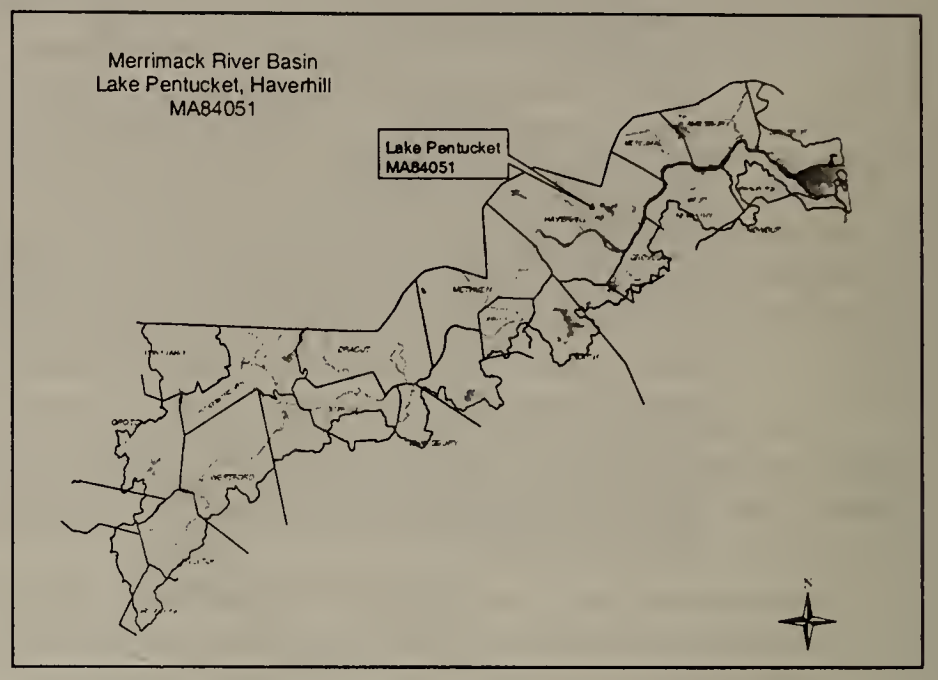
- Implement recommendations from the nutrient TMDL analysis currently being prepared by DEP.
- Coordinate with DEM and/or other groups conducting lake surveys to generate quality assured lakes data.
- Control *C. caroliniana*, *M. spicatum* and *P. crispus* and investigate the downstream spread of these species by implementing the following actions:
    - For exotic aquatic plant species that are isolated to one or a few location(s), quick action is advisable to manage these populations in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from these recorded locations (Table 5), to determine the extent of the infestation. And, "spot" treatments (refer to the draft Generic Environmental Impact Report [GEIR] for Eutrophication and Aquatic Plant Management in Massachusetts [MA DEP and DEM 1998] for advantages and disadvantages) should be undertaken to control populations at these sites before they spread further. These treatments may be in the form of carefully hand-pulling individual plants in small areas. In larger areas, other techniques such as selective herbicide application may be necessary. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These cautions will minimize the spreading of the populations. The draft GEIR (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species.

- As with the isolated cases, a program to manage the more extensive plant infestations should include additional monitoring efforts to determine the extent of the problem. The draft GEIR for Eutrophication and Aquatic Plant Management in Massachusetts (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species. Plant control options can be selected from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.) each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should be discouraged because of the propensity for these plants to reproduce and spread vegetatively (from cuttings).
- Another important component of a management plan is prevention of further spreading of these plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations occurring in unaffected areas (of this pond and to other ponds) and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert pond-users to the problem and responsibility of spreading these species.

- Review data from "Beaches Bill" required water quality testing at this segment's beach (bacteria sampling from all formal bathing beaches) to completely assess the status of the *Primary Contact Recreational Use*.

LAKE PENTUCKET (SEGMENT MA84051)

Location: Haverhill
Size: 44 acres
Classification: Class A, Public water supply
Estimated Trophic Status:



Lake Pentucket, Haverhill is also known as Round Pond.

WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Lake Pentucket (Round Pond) will be included as a source (07S) in the Haverhill Water Treatment Department's WMA permit (currently the Haverhill Water Treatment Department is exceeding their registration which is enforcement sensitive; additional technical information has to be submitted to DEP for the pending WMA permit [Casella 2001 and Okeefe 2001]).

Based on the available information there are no regulated surface wastewater discharges to this waterbody.

USE ASSESSMENT:

FISH CONSUMPTION

In 1999 fish toxics monitoring, by Normandeau and Associates, was conducted in Lake Pentucket as part of the DEP ORS mercury study. Because of elevated mercury concentrations, DPH issued a fish consumption advisory for Lake Pentucket, Haverhill (MDPH 2001a). The advisory recommends the following:

1. "The general public should not consume any fish from Lake Pentucket."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 44 acres of Lake Pentucket due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Lake Pentucket (MA84051) Use Summary Table

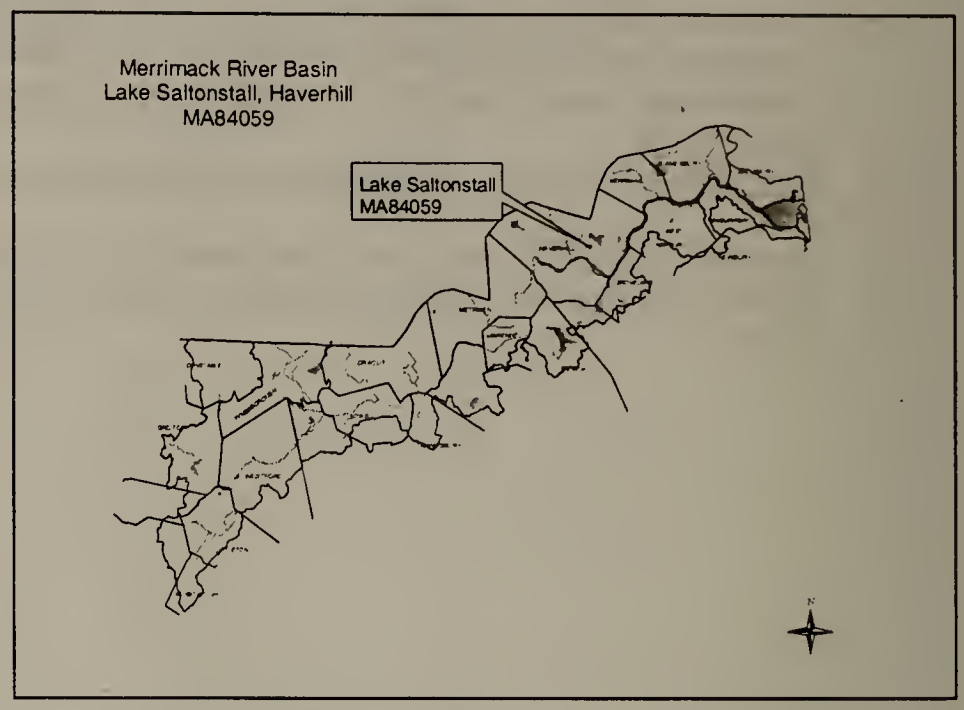
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NON-SUPPORT	Mercury		Atmospheric deposition	
Drinking Water		The DEP Drinking Water Program maintains current drinking water supply data.				
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: LAKE PENTUCKET (SEGMENT MA84051)

- When the DEP Drinking Water Program SWAP evaluations are completed, review, develop and implement recommendations to protect the Lake Pentucket drinking water supply.
- Resolve and issue Haverhill Water Department's WMA permit with appropriate limits and monitoring requirments.
- Coordinate with groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

LAKE SALTONSTALL (SEGMENT MA84059)

Location: Haverhill
Size: 45 acres
Classification: Class B
Estimated Trophic Status: Undetermined



WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Lake Saltonstall.

USE ASSESSMENT:

FISH CONSUMPTION

In 1999 fish toxics monitoring was conducted by the City of Haverhill in Lake Saltonstall as part of the DEP ORS mercury study. Because of elevated mercury concentrations, DPH issued a fish consumption advisory for Lake Saltonstall, Haverhill (MDPH 2001a). The advisory recommends the following:

1. "Children under 12 years, pregnant women and nursing mothers should eat any largemouth bass from Lake Saltonstall."
2. "The general public should limit consumption of all largemouth bass from Lake Saltonstall to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 45 acres of Lake Saltonstall due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Lake Saltonstall (MA84059) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: LAKE SALTONSTALL (SEGMENT MA84059)

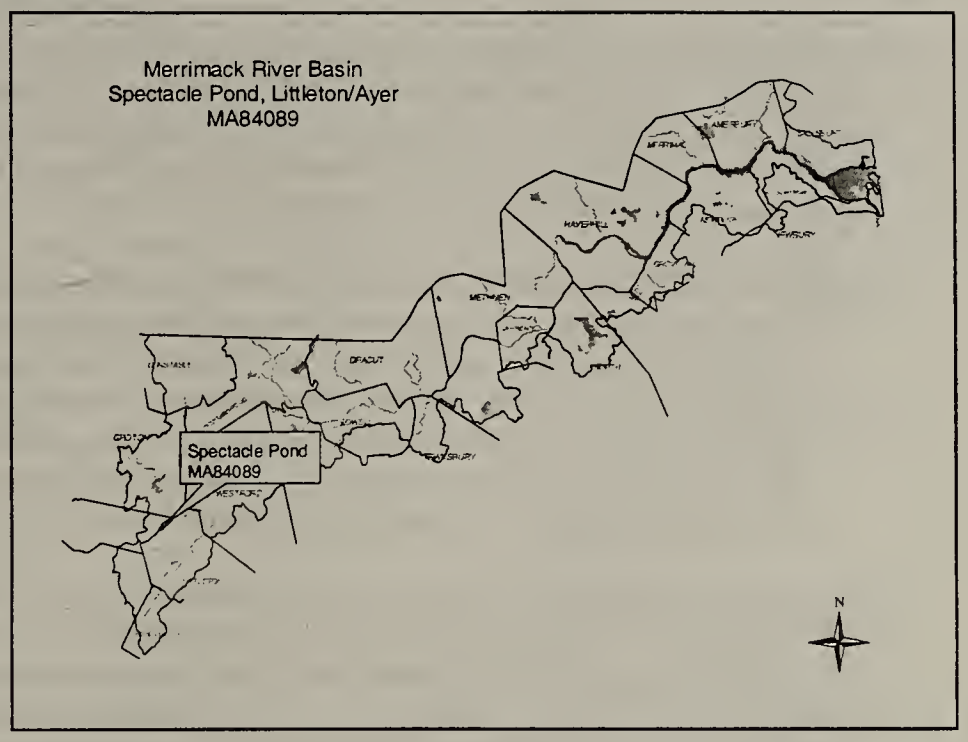
- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.
- Review data from "Beaches Bill" required water quality testing at this segment's beach (bacteria sampling from all formal bathing beaches) to assess the status of the recreational uses.

SPECTACLE POND (SEGMENT MA84089)

Location: Littleton/Ayer
Size: 79 acres
Classification: Class B
Estimated Trophic Status: Eutrophic

A Diagnostic/Feasibility Study of Spectacle Pond, Littleton/Ayer, Massachusetts was conducted in the summer and fall of 2000 by Environmental Science Services, Inc. (ESS 2001).

A shoreline and pipe (culvert and stormdrain) survey of Spectacle Pond was carried out by the MRWC and the Upper Stony Brook Stream Team volunteers in May 2000. The shoreline and pipe survey data are available in the Upper Stony Brook Watershed 2000 Shoreline Survey Report (Carney 2000).



WMA WATER WITHDRAWAL SUMMARY (TABLE D2):

Facility	PWS ID#	WMA Permit #	WMA Registration #	Source	Authorized Withdrawal (MGD)	1999 Average Withdrawal (MGD)
Ayer DPW-Water Division*	2019000		21301901	019-03G 019-04G	0.66	1.09** (see note below)
Littleton Water Department	2158000	9P21315802	21315803	158-04G	0.84reg*** 0.63per*** 1.47total***	1.14***

* The Ayer DPW is also registered and permitted in the Nashua River Basin (Grove Pond wells), ** withdrawal exceeds WMA threshold by greater than 0.1 MGD, *** indicates system-wide withdrawal; all sources are not necessarily within this segment

Note: While the Ayer DPW Water Division exceeded their WMA registration in the Merrimack River Basin, they did not exceed their WMA registered and permitted withdrawal volumes from the Nashua and Merrimack River Basin sources. They experience operational problems (clogging) at their Grove Pond wells in the Nashua River Basin and must switch to the Spectacle Pond wells. They have applied to the Department for a WMA permit to increase their withdrawal volume from the Merrimack River Basin. This application is currently under review (Lemerise 2001).

NPDES WASTEWATER DISCHARGE SUMMARY (APPENDIX D, TABLE D1):

Spectacle Pond WTF (MAG640002) was authorized to discharge (permit issue October 1995) settling tank supernate after sand filtration to Spectacle Pond. Occasionally chemical cleaning (chlorination and potassium hydroxide) of the water treatment membranes is required. This wastewater also receives treatment (neutralization) prior to any discharge via the sand filters. The Littleton Water Department filed for a renewal of their general permit in May 2001.

USE ASSESSMENT:

AQUATIC LIFE

Macrophytes

Three non-native macrophytes, *Cabomba caroliniana* (fanwort), *Myriophyllum heterophyllum* (variable milfoil), and *Potamogeton crispus* (curly-leaf pondweed) were observed by ESS during the 20 July 2000 macrophyte survey in Spectacle Pond (ESS 2001).

Chemistry-water

ESS, Inc. deployed *in-situ* meters to measure dissolved oxygen, temperature, pH, and specific conductivity at the deep hole stations in Spectacle Pond (approximately 35 feet in the southwestern basin and 15 feet in the northeastern basin). Alkalinity, turbidity and nutrient sampling was also conducted.

Because of the presence of non-native macrophytes, the *Aquatic Life Use* for the entire 79 acres of Spectacle Pond is assessed as partial support. Additionally, oxygen depletion occurred below two meters during July, August, and September 2000 (ESS 2001). Approximately 45 acres of Spectacle Pond is greater than two meters (estimated using the bathymetric map and MassGIS). In addition to exotic species, the *Aquatic Life Use* for these 45 acres is also assessessed as impaired (partial support) by organic enrichment/low dissolved oxygen.

PRIMARY* AND *SECONDARY CONTACT RECREATION* AND *AESTHETICS

Approximately 30 acres, primarily along the entire shoreline of Spectacle Pond, were densely to very densely covered with submergent and floating leaf vegetation (ESS 2001). The co-dominant species were *C. caroliniana, M. heterophyllum, Nuphar variegatum, Nymphaea odorata, Potamogeton robbinsii* and *Utricularia purpurea*. No algal blooms were observed by ESS during the surveys in July, August, and September 2000. The Secchi disc transparency was always observed as greater than the four foot (1.2 m) bathing beach criterion (ESS 2001).

Based on the dense/very dense macrophyte cover along the shoreline of Spectacle Pond, the *Primary* and *Secondary Contact Recreational* and *Aesthetics* uses were assessed as non-support for 30 acres. The *Primary Contact Recreational Use* was not assessed for the remaining 49 acres (lack of fecal coliform bacteria data) and the *Secondary Contact Recreational* and *Aesthetics* uses were evaluated as support in the 49 "open-water" acres based on best professional judegment.

Spectacle Pond (MA84089) Use Summary Table

Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		PARTIAL SUPPORT	Exotic species, Organic enrichment/low DO	Nutrients	Unknown	Urban runoff
Fish Consumption		NOT ASSESSED				
Primary Contact		NON SUPPORT – 30 acres NOT ASSESSED – 49 acres	Noxious aquatic plants	Nutrients	Unknown	Urban runoff
Secondary Contact		SUPPORT – 49 acres NON SUPPORT – 30 acres	Noxious aquatic plants	Nutrients	Unknown	Urban runoff
Aesthetics		SUPPORT – 49 acres NON SUPPORT – 30 acres	Noxious aquatic plants	Nutrients	Unknown	Urban runoff

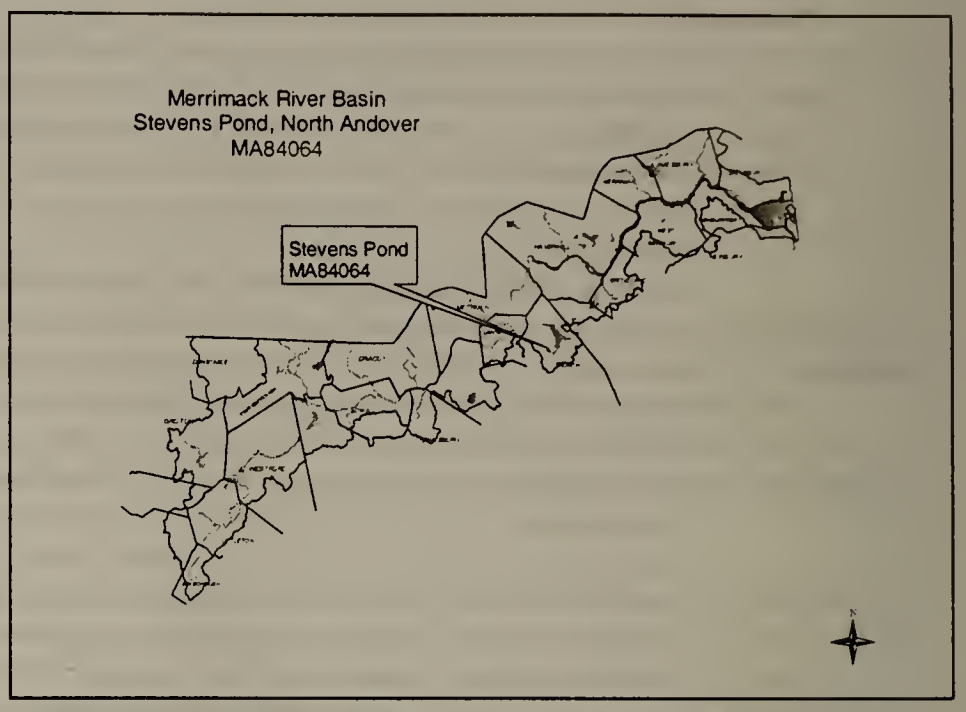
RECOMMENDATIONS: SPECTACLE POND (SEGMENT MA84089)

- Review recommendations for restoration/preservation from the Diagnostic/Feasibility Study of Spectacle Pond (ESS 2001):
  - effect implementation of aquatic plant management
  - develop a detailed plan to reduce pollutants associated with storm events and to maintain and enhance fish and wildlife habitat
  - establish a long-term monitoring program that identifies potential problems and documents effectiveness of any implemented management measures.
- Develop and reissue Spectacle Pond WTF (MAG640002) NPDES permit.
- As part of the WMA 5-year review process, DEP should continue to evaluate Littleton Water Department's compliance with their WMA registration and/or permit limits.
- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- Support the Upper Stony Brook Stream Teams priorities (Carney 2000) for action including:
  - Clean out and repair culverts around Spectacle Pond
  - Education of local community for BMPs to control the spread of non-native aquatic vegetation

- Control *C. caroliniana*, *M. heterophyllum* and *P. crispus* and investigate the downstream spread of these species by implementing the following actions:
    - For exotic aquatic plant species that are isolated to one or a few location(s), quick action is advisable to manage these populations in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from these recorded locations (Table 5), to determine the extent of the infestation. And, "spot" treatments (refer to the draft Generic Environmental Impact Report [GEIR] for Eutrophication and Aquatic Plant Management in Massachusetts [MA DEP and DEM 1998] for advantages and disadvantages) should be undertaken to control populations at these sites before they spread further. These treatments may be in the form of carefully hand-pulling individual plants in small areas. In larger areas, other techniques such as selective herbicide application may be necessary. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These cautions will minimize the spreading of the populations. The draft GEIR (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species.
    - As with the isolated cases, a program to manage the more extensive plant infestations should include additional monitoring efforts to determine the extent of the problem. The draft GEIR for Eutrophication and Aquatic Plant Management in Massachusetts (MA DEP and DEM 1998) should be consulted prior to the development of any pond management plan to control exotic aquatic plant species. Plant control options can be selected from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.) each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should be discouraged because of the propensity for these plants to reproduce and spread vegetatively (from cuttings).
    - Another important component of a management plan is prevention of further spreading of these plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations occurring in unaffected areas (of this pond and to other ponds) and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert pond-users to the problem and responsibility of spreading these species.
- Resolve and issue Ayer DPW-Water Division's WMA permit with appropriate limits and monitoring requirments.

STEVENS POND (SEGMENT MA84064)

Location: North Andover
Size: 26 acres
Classification: Class B
Estimated Trophic Status: Undetermined



WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Stevens Pond.

USE ASSESSMENT:

FISH CONSUMPTION

In 1999 fish toxics monitoring, by Normandeau and Associates, was conducted in Stevens Pond as part of the DEP ORS mercury study. Because of elevated mercury concentrations, MDPH issued a fish consumption advisory for Stevens Pond, North Andover (MDPH 2001a). The advisory recommends the following:

1. "Children under 12 years, pregnant women and nursing mothers should eat any largemouth bass from Stevens Pond."
2. "The general public should limit consumption of all largemouth bass from Stevens Pond to two meals per month."

Because of the site-specific MDPH fish consumption advisory, the *Fish Consumption Use* is non-support for the 26 acres of Stevens Pond due to mercury contamination. It should be noted that a statewide fish consumption advisory is also in effect (see Fish Consumption Use assessment guidance, page 7).

Stevens Pond (MA84064) Use Summary Table

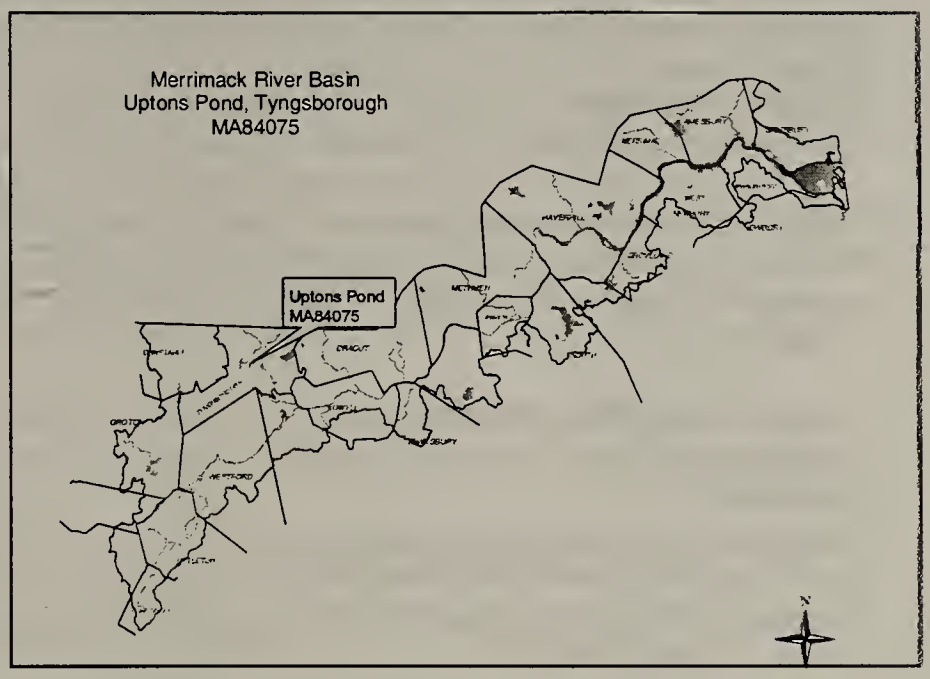
Designated Uses		Status	Causes		Sources	
			Known	Suspected	Known	Suspected
Aquatic Life		NOT ASSESSED				
Fish Consumption		NON SUPPORT	Mercury		Atmospheric deposition	
Primary Contact		NOT ASSESSED				
Secondary Contact		NOT ASSESSED				
Aesthetics		NOT ASSESSED				

RECOMMENDATIONS: STEVENS POND (SEGMENT MA84064)

- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.
- Review data from "Beaches Bill" required water quality testing at this segment's beach (bacteria sampling from all formal bathing beaches) to assess the status of the recreational uses.

UPTONS POND (SEGMENT MA84075)

Location: Tyngsborough
Size: 7 acres
Classification: Class B
Estimated Trophic Status: Undetermined



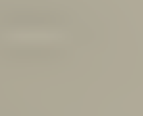
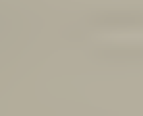
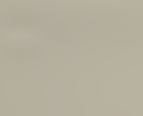
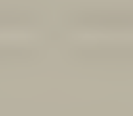
WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Uptons Pond.

USE ASSESSMENT SUMMARY:

No current data/information was available, therefore, all uses are currently not assessed.

Uptons Pond (MA84075) Use Summary Table

Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
				
Not Assessed				

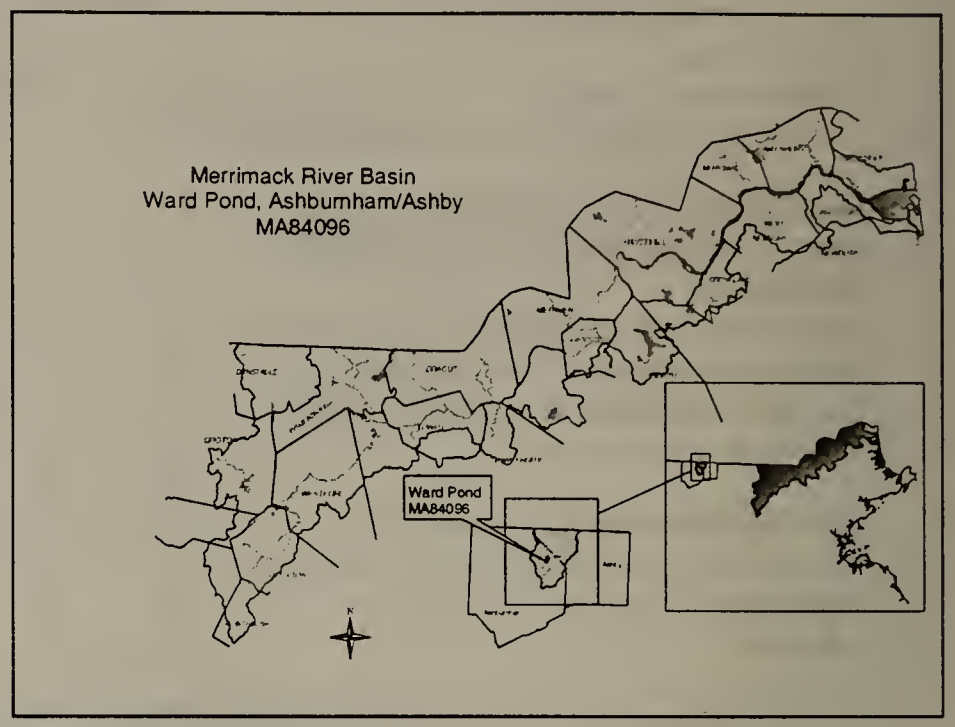
RECOMMENDATIONS: UPTONS POND (SEGMENT MA84075)

- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

WARD POND (SEGMENT MA84096)

Location: Ashburnham
Size: 51 acres
Classification: Class B
Estimated Trophic Status: Eutrophic

This pond, also known as Billy Ward Pond, is on the 1998 303(d) list of impaired waters for organic enrichment/low DO (Table 3).



WMA WATER WITHDRAWAL AND NPDES WASTEWATER DISCHARGE SUMMARY:

Based on the available information, there are no regulated water withdrawals or surface wastewater discharges in the vicinity of Ward Pond.

USE ASSESSMENT SUMMARY:

No current data/information was available, therefore, all uses are currently not assessed.

Ward Pond (MA84096) Use Summary Table

Aquatic Life	Fish Consumption	Primary Contact	Secondary Contact	Aesthetics
Not Assessed				

RECOMMENDATIONS: WARD POND (SEGMENT MA84096)

- Coordinate with DEM and/or other groups conducting lake and watershed surveys to generate quality assured lakes data.
- As part of any lake water quality evaluation, include identification of non-native species and mapping of macrophyte cover in order to evaluate the status of the *Aquatic Life*, *Recreational* and *Aesthetic* uses.

RECOMMENDATIONS – LAKES

- For non-native aquatic or wetland plant species that were isolated to one or a few location(s) quick action is advisable to manage these populations in order to alleviate the need for costly and potentially fruitless efforts to do so in the future. Two courses of action should be pursued concurrently. More extensive surveys need to be conducted, particularly downstream from these recorded locations, to determine the extent of the infestation (Table 5). And, "spot" treatments should be undertaken to control populations at these sites before they spread further. These treatments may be in the form of carefully hand pulling individual plants, in small areas, or selective herbicide applications in larger areas. In either case, the treatments should be undertaken prior to fruit formation and with a minimum of fragmentation of the individual plants. These cautions will minimize the spreading of the populations.

Table 5. Non-native aquatic plant species locations (**in bold**) in the Merrimack River Basin and their possible paths of downstream spreading (Appendix B, Table B10).

Cabomba caroliniana **(Fanwort)**

Forge Pond (Littleton/Westford) ⇒ Stony Brook (through unnamed impoundments, Graniteville Pond, Westford, and Westford Station Pond, Westford) ⇒ Merrimack River (Chelmsford)
Lake Mascuppic (Dracut/Tynsborough) ⇒ unnamed tributary (through an unnamed impoundment) ⇒ Lawrence Brook ⇒ Merrimack River (Tyngsborough)

Newfield Pond (Chelmsford) ⇒ unnamed tributary ⇒ Stony Brook ⇒ Merrimack River (Chelmsford)

Spectacle Pond (Littleton) ⇒ Gilson Brook ⇒ **Forge Pond** (Littleton/Westford) ⇒ Stony Brook (through unnamed impoundments, Graniteville Pond, Westford, and Westford Station Pond, Westford) ⇒ Merrimack River (Chelmsford)

Myriophyllum heterophyllum **(Variable water milfoil)**

Flint Pond (Tyngsborough) ⇒ unnamed tributary (through an unnamed impoundment) ⇒ Merrimack River (Tyngsborough)

Knops Pond/Lost Lake (Groton) ⇒ unnamed tributary ⇒ Whitney Pond (Groton) ⇒ Cow Pond Brook (including Upper Massapoag Pond, Groton/Tyngsborough ⇒ **Massapoag Pond** (Groton/Dunstable) ⇒ Salmon Brook (including Lower Massapoag Pond , Dunstable) ⇒ to confluence with Merrimack River in New Hampshire

Massapoag Pond (Groton/Dunstable) ⇒ Salmon Brook (including Lower Massapoag Pond, Dunstable) ⇒ to confluence with Merrimack River in New Hampshire

Spectacle Pond (Littleton) ⇒ Gilson Brook ⇒ **Forge Pond** (Littleton/Westford) ⇒ Stony Brook (through unnamed impoundments, Graniteville Pond, Westford, and Westford Station Pond, Westford) ⇒ Merrimack River (Chelmsford)

Myriophyllum spicatum **(Eurasian water milfoil)**

Newfield Pond (Chelmsford) ⇒ unnamed tributary ⇒ Stony Brook ⇒ Merrimack River (Chelmsford)

Najas minor **(European naiad)**

Flint Pond (Tyngsborough) ⇒ unnamed tributary (through an unnamed impoundment) ⇒ Merrimack River (Tyngsborough)

Potamogeton crispus **(Curly leaf pondweed)**

Forge Pond (Littleton/Westford) ⇒ Stony Brook (through unnamed impoundments, Graniteville Pond, Westford, and Westford Station Pond, Westford) ⇒ Merrimack River (Chelmsford)
Lake Mascuppic (Dracut/Tynsborough) ⇒ unnamed tributary (through an unnamed impoundment) ⇒ Lawrence Brook ⇒ Merrimack River (Tyngsborough)

Massapoag Pond (Groton/Dunstable) ⇒ Salmon Brook (including Lower Massapoag Pond, Dunstable) ⇒ to confluence with Merrimack River in New Hampshire

Newfield Pond (Chelmsford) ⇒ unnamed tributary ⇒ Stony Brook ⇒ Merrimack River (Chelmsford)

Spectacle Pond (Littleton) ⇒ Gilson Brook ⇒ **Forge Pond** (Littleton/Westford) ⇒ Stony Brook (through unnamed impoundments, Graniteville Pond, Westford, and Westford Station Pond, Westford) ⇒ Merrimack River (Chelmsford)

- As with the isolated cases, a program to manage the more extensive plant infestations should include additional monitoring efforts to determine the extent of the problem. Plant control aspects of any plan to

manage the non-native aquatic species mentioned above can select from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.), each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should be discouraged because of the propensity for these plants to reproduce and spread vegetatively (from cuttings).

- Another important component of a management plan is prevention of further spreading of these plants. Once the extent of the problem is determined and control practices are exercised vigilant monitoring needs to be practiced to guard against infestations occurring in unaffected areas and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert lake-users to the problem and responsibility of spreading these species.

- Coordinate with DEM to generate quality assured lakes data and conduct more intensive lake and watershed surveys to better determine the lake trophic and use support status and identify causes and sources of impairment.

LITERATURE CITED

Ackerman, M.T., 1989. *Compilation of Lakes, Ponds, Reservoirs* and *Impoundments Relative to the Massachusetts Lake Classification Program.* Publication: #15901-171-50-4-89-c.r. Technical Services Branch, Massachusetts Division of Water Pollution Control, Department of Environmental Quality Engineering, Westborough, MA.

ACOE. 2001. *Update Report for Massachusetts April 30, 2001.* US Army Corps of Engineers New England District, Concord, MA.

Anderson, K. R. 2000. *Inspection Report Westford Anodizing Corporation.* Massachusetts Department of Environmental Protection, Central Regional Office, Worcester, MA.

ARC. 1998. *Benthic Invertebrate Analysis of the Spicket River, Lawrence, Massachusetts: Comparison of the Six Surveys Conducted over a Three-Year Period (1995-1997).* Project No. 230C. Aquatic Resource Center, Franklin, TN.

Barber, R. 2001a. *Nonpoint Source Action Strategy – Merrimack River Basin.* Massachusetts Department of Environmental Protection, Northeast Regional Office, Wilmington, MA.

Barber, R. 2001b. *Merrimack WQ Assessment Report Comments.* Massachusetts Department of Environmental Protection, Northeast Regional Office. E-mail to Laurie Kennedy at Massachusetts Department of Environmental Protection dated 14 August 2001.

Beattie, M. (Mike.Beattie@state.ma.us). 2001. *Extent of Merrimack River fish advisory.* Department of Public Health, Boston. E-mail to Robert Maietta at Massachusetts Department of Environmental Protection dated 24 September 2001.

BEC. 1987. *A Diagnostic/Feasibility Study for the Management of Forge Pond, Westford Massachusetts.* Baystate Environmental Consultants, Inc., East Longmeadow, MA.

BEC. 1992. *A Diagnostic/Feasibility Study for the Management of Lost Lake/Knopp's Pond Groton, Massachusetts.* Baystate Environmental Consultants, Inc., East Longmeadow, MA.

Blumeris, B.R. 2001a. Personal Communication. *Lowell Heritage State Park Beach – possible bacteria sources.* U.S. Army Corps of Engineers, New England District, Concord, MA. 16 August 2001.

Blumeris B.R. (Barbara.R.Blumeris@nae02.usace.army.mil). 2001b. *Merrimack Information.* U.S. Army Corps of Engineers, New England District. E-mail to Stella.Kiras and Laurie.Kennedy at Massachusetts Department of Environmental Protection dated 17 August 2001.

Brander, K. (Kevin.Brander@state.ma.us). 2001. *Merrimack CSOs.* Department of Environmental Protection, Northeast Regional Office, Wilmington. E-mail to Laurie.Kennedy at Massachusetts Department of Environmental Protection dated 28 August 2001.

Carley, M. 1999. *Shoreline Survey Report and Action Plan for Cobbler Brook in Merrimac.* Merrimack River Watershed Council. Lawrence, MA.

Carney, C. 2000. *Shoreline Survey Report and Action Plan for the Upper Stony Brook Watershed.* Merrimack River Watershed Council, Lawrence, MA.

Casella, Mark. 2001. Personal Communication. *Merrimack River Basin information.* Massachusetts Department of Environmental Protection, Northeast Regional Office. Wilmington, MA.

CDM. 1999. *Town of Amesbury Lake Attitash Watershed Management Plan.* Camp, Dresser & McKee, Inc., Cambridge, MA.

CDM. 2000. *Draft Long-Term CSO Control Plan/Draft Environmental Impact Report (EOEA#12088) Volume I-Report for Haverhill (September 2000).* Camp, Dresser & McKee, Inc., Cambridge, MA.

CDM. 2001a. *Draft LRWWU Long-term CSO Control Plan (June 2001).* Camp, Dresser & McKee, Inc., Manchester, NH.

CDM. 2001b. *GLSD Interim CSO Report (April 2001).* Camp, Dresser & McKee, Inc., Cambridge, MA.

Celona, M. (Mike.Celona@state.ma.us) 2001. *Flint Pond.* Communication with Massachusetts Department of Public Health. MA. E-mail to Robert Maietta, MA DEP dated 9 July 2001.

Chalmers, A. T. (chalmers@usgs.gov) 2001. *Toxics Substances Hydrology Program Sampling in the Merrimack River Basin.* Communication with USGS, Montpelier, VT. E-mail to Stella Kiras, MA DEP dated 13 August 2001.

Churchill, N. 1999. Personal Communication. *Shellfish Project Classification Area Information as of 1 January 1999.* Department of Fisheries, Wildlife, and Environmental Law Enforcement, Division of Marine Fisheries, Pocasset, MA.

Davis, B. 2001. Personal Communication. *Status of ITT Semiconductor, Inc., NPDES discharge.* US Environmental Protection Agency, Boston, MA. 17 September 2001.

DFWELE. 2000. *Designated Shellfish Growing Areas Datalayer – October 2000.* Published by MassGIS (MA Office of Geographic and Environmental Information), Executive Office of Environmental Affairs, Department of Fisheries, Wildlife, and Environmental Law Enforcement, Division of Marine Fisheries, Boston, MA.

Domizio, L. 2001. Personal Communication. *Merrimack River Basin: Phase II stormwater permit requirements.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

Dumas, E. 2001. Letter to Ms. Olga Vergara dated 20 April 2001. *NPDES Non-Contact Cooling Water General Permit and Vernon Plastics Individual Permit No. MA0002984.* Vernon Plastics, Haverhill, MA.

Enrico, J. 2000a. *Environmental and Public Use Inspecttion Report Project Number 2790-MA.* FERC RIMS DOC 2088186. http://rimsweb1.www.ferc.fed.us. 24 August 2001.

Enrico, J. 2000b. *Environmental and Public Use Inspecttion Report Project Number 2800-MA.* FERC RIMS DOC 2088187. http://rimsweb1.www.ferc.fed.us. 24 August 2001.

Enrico, J. 2001. Personal Communication. *Aquatic Life Use Quality in the Merrimack River below Pawtucket Dam.* Federal Energy Regulatory Commission (FERC), New York. 23 August 2001.

Environmental Law Reporter. 1988. *Clean Water Deskbook.* Environmental Law Institute, Washington, D.C.

EPA. 1997. *Guidelines for Preparation of the Comprehensive State Water Quality Assessments (305(b) Reports) and Electronic Updates: Report Contents.* U.S. Environmental Protection Agency. Assessment and Watershed Protection Division (4503F). Office of Wetlands, Oceans, and Watersheds. Office of Water, Washington D.C.

EPA. Undated. Superfund: State, Tribal, and Site Identification Center NPL Site Narrative at Listing. [Online] http://www.epa.gov/superfund/sites/npl/nar25.htm. 30 July 2001.

ESS. 2001. *A Diagnostic/Feasibility Study of Spectacle Pond, Littleton/Ayer, Massachusetts.* Environmental Science Services, Inc., Wellesley, MA.

FERC. 2001a. *Order issue subsequent license – minor project.* FERC RIMS Document ID 2129521. http://rimsweb1.www.ferc.fed.us. 23 August 2001.

FERC. 2001b. *Letter to Caleb Slater from Edward Abrams Project Nos. 2927 and 2928.* FERC RIMS Document 2087652. http://rimsweb1.www.ferc.fed.us. 23 August 2001.

Flanagan, S.M., Nielsen, M.G., Robinson, K.W. and Coles, J.F. 1999. *Water-Quality Assessment of the New England Coastal Basins in Maine, Massachusetts, New Hampshire, and Rhode Island: Environmental Settings and Implications for Water Quality and Aquatic Biota.* U.S. Geological Survey Water-Resources Investigations Report 98-4249. National Water-Quality Assessment Program, Pembroke, New Hampshire.

Fullford, R. C. Hampton, S. Glatt, and N. Hatfield. 2000. *Shoreline Survey Report and Action Plan for the Lower Stony Brook Watershed.* Merrimack River Watershed Council, Lawrence, MA.

Garabedian S.P. (sgarabed@usgs.gov). 2001. *Seven-day, ten-year low flow estimate for the Merrimack River at the Lowell gage.* Communication with USGS, Northborough, MA. E-mail to Laurie Kennedy, MA DEP dated 21 August 2001.

Goodno, R. 2001. Personal Communication. *Merrimack River Basin information.* Merrimack River Watershed Council, Lawrence, MA. 16 August 2001.

Hack, W. 2001a. (wallace.hack@state.ma.us) 2001. *Veryfine's treatment system.* Communication with DEP Central Regional Office, Bureau of Waste Prevention, Worcester, MA. E-mail to Laurie Kennedy, MA DEP dated 30 August 2001.

Halliwell, D.B., W.A. Kimball and A.J. Screpetis. 1982. *Massachusetts Stream Classification Program Part I: Inventory of Rivers and Streams.* Massachusetts Division of Fisheries and Wildlife, Department of Fisheries, Wildlife, and Recreational Vehicles and Massachusetts Division of Water Pollution Control, Department of Environmental Quality Engineering. Westborough, MA.

Himes, J. and G. Roscoe. 1995. *Draft Inspection Report for Middlesex Materials Corporation.* Massachusetts Department of Environmental Protection, Central Regional Office, Worcester, MA.

Hogan, P.H. 2001. Personal Communication. *Merrimack River Basin: NPDES permitting information.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

Hull, R. 2001. Personal Communication. *Compliance and Enforcement Status of Westford Anodizing Company.* US EPA. Boston, MA. 10 September 2001.

IEP. 1988. *Mill Pond Diagnostic/Feasibility Study West Newbury, Massachusetts.* IEP, Inc. Northborough, MA.

ISSC. 2000. *Interstate Shellfish Sanitation Conference, National Shellfish Sanitation Program Guide for the Control of Molluscan Shellfish.*

Jonash, J. 1986. *Toxics in Fish Data from Flint Pond, Tyngsborough.* Department of Environmental Quality Engineering, Technical Services Branch, Westboro. MA. Memorandum dated 12 June 1986.

Kaye, V. 1998a. *Operation Report Electronic Filing Federal Energy Regulatory Commission Project Number 2927-MA.* FERC RIMS DOC 1888269. http://rimsweb1.www.ferc.fed.us. 23 August 2001.

Kaye, V. 1998b. *Operation Report Electronic Filing Federal Energy Regulatory Commission Project Number 2928-MA.* FERC RIMS DOC 1893618. http://rimsweb1.www.ferc.fed.us. 23 August 2001.

Kaye, V. 1999. *Operation Report Electronic Filing Federal Energy Regulatory Commission Project Number 9300-MA.* FERC RIMS DOC 1893618. http://rimsweb1.www.ferc.fed.us. 23 August 2001.

Kaye, V. 2000. *Operation Report Electronic Submittal Federal Energy Regulatory Commission Project Number 2790-MA.* FERC RIMS DOC 2046057. http://rimsweb1.www.ferc.fed.us. 23 August 2001.

Kaye, V. 2001a. *Operation Report Federal Energy Regulatory Commission Project Number 2800-MA.* FERC RIMS DOC 2131645. http://rimsweb1.www.ferc.fed.us. 23 August 2001.

Kaye, V. 2001b. *Operation Report Federal Energy Regulatory Commission Project Number 8093-MA.* FERC RIMS DOC 2131652. http://rimsweb1.www.ferc.fed.us. 23 August 2001.

Kennedy, J. (jeff.kennedy@state.ma.us). 2001. *Sanitary Survey Database Printout.* Department of Fisheries, Wildlife, and Environmental Law Enforcement, Division of Marine Fisheries, Shellfish Management Program. Newburyport, MA. E-mail to Stella Kiras, MA DEP dated 15 June 2001.

Kish, J. and L. Roy. 1999. *Shoreline Survey Report and Action Plan for Bare Meadow Brook.* Merrimack River Watershed Council. Lawrence, MA.

Laing, H.F. 1996. Letter to John Kronopolous dated 3 July 1996. *In the matter of Westford Anodizing Corp., MA0024414.* US EPA, Office of Environmental Stewardship, Boston, MA.

Lemerise, A. 2001. Personal Communication. *Ayer DPW Water Division WMA status.* Massachusetts Department of Environmental Protection, Central Regional Office. Worcester, MA. 10 September 2001.

LeVangie, D. 2001. *Water withdrawal registration and permit information.* Water Management Act Database. Massachusetts Department of Environmental Protection, Division of Watershed Management, Database Manager. Boston, MA.

Lycott. 1989. *Diagnostic/Feasibility Study Long Pond Dracut, Massachusetts.* Lycott Environmental Research, Inc., Southbridge, MA.

Lycott. 1990a. *Diagnostic/Feasibility Study Forest Lake Methuen, Massachusetts.* Lycott Environmental Research, Inc., Southbridge, MA.

Lycott. 1990b. *Diagnostic/Feasibility Study Lake Mascuppic, Tyngsborough/Dracut, Massachusetts.* Lycott Environmental Research, Inc., Southbridge, MA.

MA DEM. 1993. *Areas of Critical Environmental Concern (ACEC) Program Guide June 1993.* Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Department of Environmental Management, ACEC Program, Boston, MA.

MA DEP. 1996. (Revision of 1995 report). *Massachusetts surface water quality standards.* Massachusetts Department of Environmental Protection, Division of Water Pollution Control, Technical Services Branch. Westborough, MA 114p. (Revision of 314 CMR 4.00, effective June 23, 1996.)

MA DEP and DEM. 1998. *Eutrophication and Aquatic Plant Management in Massachusetts Draft Generic Environmental Impact Report.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA and Massachusetts Department of Environmental Management, Boston, MA.

MA DEP. 1999a. *Final Massachusetts Section 303(d) List of Waters 1998.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

MA DEP. 1999b. *Baseline Lake Survey Quality Assurance Project Plan dated 14 July 1999.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

MA DEP. 1999c. *Draft Quality Assurance Project Plan (CN13.0) Fish Contaminant Monitoring Program 1999.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

MA DEP. 1999d. *Quality Assurance Project Plan (CN7.0) For 1999 Benthic Macroinvertebrate Biomonitoring.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

MA DEP. 1999e. Open file. *DWM 1999 Lake TMDL field sheets.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

MA DEP. 2000a. *Commonwealth of Massachusetts Summary of Water Quality 2000.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

MA DEP. 2000b. *Draft Fish Mercury Concentrations in Northeastern Massachusetts Lakes.* Massachusetts Department of Environmental Protection, Office of Research and Standards, Boston, MA.

MA DEP. 2000c. Open files. *License applications for herbicide treatment: 1996 through 2000.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

MA DEP. 2001a. Open File. *PALIS updates.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

MA DEP. 2001b. *Open NPDES permit files.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

MA DEP. 2001c. Open file. *DWM 1983 survey sheets and bathymetric map for Johnson Pond.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

Maietta, R.J. 1988. Memorandum to Arthur Johnson, Biomonitoring Program Manager, DEQE, TSB, 17 February 1988. *1987 Bailey Pond Fish Toxics Monitoring.* Massachusetts Department of Environmental Quality Engineering, Division of Water Pollution Control,Technical Services Branch, Westborough, MA.

Maietta, R.J. 1999. *1998 Fish Toxics Monitoring Public Request Surveys.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

Major, A.R. and K.C. Carr. 1991. *Contaminant Concentrations in Merrimack River Fish.* Report Number RY91-NEFO-1-EC. US Fish and Wildlife Service, Concord, NH.

Major, A.R. 2001. Personal Communication. *USFWS 1998 Study of Contaminant Concentrations in Merrimack River Fish.* US Fish and Wildlife Service, Concord, NH. 26 July 2001.

MassGIS. 2000. *Hydrography - statewide 1:25000.* MassGIS (MA Office of Geographic and Environmental Information), Executive Office of Environmental Affairs, Boston, MA.

Mattson, M. 2001. Personal Communication. *Merrimack River Basin Lake TMDL Status.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

McDonald, D. 1999. Letter to Drew Major, USFWS dated 27 September 1999. *Merrimack River Fish Tissue Analysis.* US EPA, Office of Environmental Measurement & Evaluation, Lexington, MA.

MDPH. 2001a. *Freshwater Fish Consumption Advisory List.* Massachusetts Department of Public Health, Bureau of Environmental Health Assessment. Boston, MA.

MDPH. 2001b. *Public Health* Statewide *Fish Consumption Advisory issued July 2001.* The Commonwealth of Massachusetts, Bureau of Environmental Health Assessment, Boston, MA.

Monnelly, A. and J. Strauss. 2001a. *Stony Brook Watershed Assessment.* Merrimack River Watershed Council, Lawrence, MA.

Monnelly, A. and J. Strauss. 2001b. *Powow River Watershed Assessment Final Report.* Merrimack River Watershed Council, Lawrence, MA.

MRWC. 1999. *Spicket River Revitilization Project Nonpoint Source Project Number 96-05-319.* Merrimack River Watershed Council, Lawrence, MA.

MRWC. 2000. *2000 Water Quality Monitoring Results Cobbler's Brook and Bare Meadow Brook.* Merrimack River Watershed Council, Lawrence, MA.

Murphy, C.P. 1999. *The Lowell Reach of the Merrimack River Water Quality Report 1999.* Lowell Regional Wastewater Utility, Lowell, MA.

Murphy, C.P. 2000. *The Lowell Reach of the Merrimack River Water Quality Report 2000.* Lowell Regional Wastewater Utility, Lowell, MA.

Neas, R. 2001. *Permit Compliance System Database for NPDES: Status of Massachusetts NPDES permits.* U.S. Environmental Protection Agency, Region I, Office of Environmental Stewardship, Water Technical Unit (SEW). Boston, MA.

Nelson, D.K. (Donna.Nelson-DEM@state.ma.us). 2001. *Across State Lines: Massachusetts & New Hampshire Interstate Cooperation in Flood Mitigation Along the Spicket River.* Massachusetts Department of Environmental Management and Massachusetts Emergency Management Agency, Boston. E-mail to Laurie.Kennedy at Massachusetts Department of Environmental Protection dated 20 August 2001.

NH DES. 2001. *1998 305(b) List for NH Rivers and Streams Merrimack River Basin.* [Online] New Hampshire Department of Environmental Services http://www.des.state.nh.us/wmb/1998-305b.pdf . [4 October 2001].

Notini, B.R. and E.M. Chagnon. 1980. *Lake Attitash Water Quality Study 1977-1978.* Massachusetts Department of Environmental Quality Engineering, Division of Water Pollution Control, Westborough, MA.

Nutter, P. 11 July 2001. Consolidated Hydro, Inc. clarification on fish passages along the Merrimack River. Phone conversation with S. Kiras (MA DEP, DWM).

O'Keefe, K. 2001. Personal Communication. *Merrimack River Basin WMA registration and permitting information and 1999 average annual withdrawal volumes.* Massachusetts Department of Environmental Protection, Northeast Regional Office, Wilmington, MA.

O'Leary, C.J. 1993. Letter to Dr. Jay D. Hair dated 5 March 1993. *Veryfine Products, Inc. Littleton, MA.* Department of Environmental Protection Central Regional Office, Worcester, MA.

Persaud, D., R. Jaagumagi, and A. Hayton. 1993. *Guidelines for the protection* and *management of aquatic sediment quality in Ontario.* Water Resources Branch, Ontario Ministry of the Environment. Ontario, Canada.

Rapp, A. 1999a. *Shoreline Survey Report and Action Plans for the Salmon Brook Watershed.* Merrimack River Watershed Council, Lawrence, MA.

Rapp, A. 1999b. *Shoreline Survey Report and Action Plan for Lawrence Brook.* Merrimack River Watershed Council, Lawrence, MA.

Roach, D. August 2001. Personal communication. *Massachusetts Division of Marine Fisheries sampling program description (sampling sites, methods, goals).* Phone conversation with S. Kiras (MA DEP, DWM).

Rojko, A. M., W. A. Kimball, and A. J. Screpetis. 1995. *Designated Outstanding Resource Waters of Massachusetts 1995.* Massachusetts Executive Office of Environmental Affairs, Department of Environmental Protection, Bureau of Resource Protection, Office of Watershed Management, Grafton, MA.

Saravanapavan, T. 2001. *Data and Literature on the Water Use of the Merrimack River Watershed.* Merrimack River Watershed Council, Lawrence, MA.

Scarlet, G. 2001. Personal Communication. *Merrimack River Basin: Stormwater permitting information.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

Scott, R. 1999. Facsimile to Bill Dunn dated 12 August 1999. *Sampling data from swimming site at Lowell Heritage State Park.* Department of Environmental Management, Division of Forest and Parks Region II, Carlisle, MA.

Scott, R. 2001. Personal Communication. *Lowell Heritage State Park beach closures.* Department of Environmental Management, Division of Forest and Parks Region II, Carlisle, MA.

Smith, J.B., R.M. Nuzzo, and G.M.Szal, 1990. *Assessment of unassessed waters in the Merrimack River Basin using rapid biological monitoring.* Massachusetts Department of Environmental Protection, Division of Water Pollution Control, Technical Services Branch, Westborough, MA.

Socolow, R.S., J.L. Zanca, D. Murino Jr., and L.R. Ramsbey. 2000. *Water Resources Data for Massachusetts* and *Rhode Island, Water Year 1999.* U.S. Geological Survey Report MA-RI-99-1. Water Resources Division, Northboro, MA.

Socolow, R.S., J.S. Whitley, D. Murino, Jr., and L.R. Ramsbey. 2001. *Water Resources Data for Massachusetts* and *Rhode Island, Water Year 2000.* U.S. Geological Survey Report MA-RI-00-1. Water Resources Division, Northborough, MA.

Tatsutani, M. Editor. NESCAUM, NEWMOA, NEIWPCC, EMAN. 1998. *Northeast States/Eastern Canadian Provinces Mercury Study A Framework for Action.* Northeast States for Coordinated Air Use Management (NESCAUM), Northeast Waste Management Official's Association (NEWMOA), New England Interstate Water Pollution Control Commission (NEIWPCC), and Canadian Ecological Monitoring and Assessment Network (EMAN).

UMass Amherst. 1999. *Land Use Datalayer - statewide 1:25000.* Published by MassGIS (MA Office of Geographic and Environmental Information), Executive Office of Environmental Affairs for the Resource Mapping Project at the University of Massachusetts Amherst, MA.

USEPA. 1999. *1999 Update of Ambient Water Quality Criteria for Ammonia.* U.S. Environmental Protection Agency, Office of Water and Office of Science and Technology, Washington D.C. and Office of Research and Development, Duluth, MN.

USFWS July 2001a. *Progress Report Merrimack River Anadramous Fish Restoration program 1996 – 1997.* [Online] U.S. Fish and Wildlife Service http://www.fws.gov/r5cneafp/links.html. [29 November 2000].

USFWS July 2001b. *Strategic Plan for the Restoration of Anadromous Fish to the Merrimack River.* [Online] U.S. Fish and Wildlife Service http://www.fws.gov/r5cneafp/links.html. [29 November 2000].

USFWS July 2001c. *Status of Anadromous Fish Restoration.* [Online] U.S. Fish and Wildlife Service http://www.fws.gov/r5cneafp/links.html. [29 November 2000].

USFWS July 2001d. *Restoration Program Background The Beginning Through 1996.* [Online]. U.S. Fish and Wildlife Service http://www.fws.gov/r5cneafp/table.html. [29 November 2000].

USFWS July 2001e. *Merrimack River Anadramous Fish Returns.* [Online]. U.S. Fish and Wildlife Service http://www.fws.gov/r5cneafp/table.html. [29 November 2000].

USGS. 13 June 2001. *Surface-Water Monitoring Activities – Updated August 2000.* [Online]. United States Geological Survey. http://nh.water.usgs.gov/CurrentProjects/nawqa/pdf/sw_web.pdf , 8/18/00.

Weinstein, M.J. and Connors, S. G. 2001. *Parker River Watershed Water Quality Assessment Report.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

Zimmerman, M. 03 August 2001. Personal communication. *Confirmation of dissolved oxygen data for Merrimack River at the Lowell Gage.* Phone conversation with L. Kennedy. (MA DEP, DWM).

LIST OF APPENDICES, TABLES AND FIGURES

APPENDIX A – DATA VALIDATION REPORT FOR 1999 DEP/DWM MERRIMACK WATERSHED MONITORING DATA

Table A2.1.1 1999 Data Symbols and Qualifiers
Table A5.1.1 1999 DEP DWM Censored/Qualified Hydrolab Data.
Table A5.2.1 1999 DEP DWM inlake physico-chemical QA/QC field blank data.
Table A5.2.2 1999 DEP DWM inlake physico-chemical QA/QC field replicate data.
Table A5.2.3.1 1999 DEP DWM Censored/Qualified Discrete Water Sample Data.
Table A5.4.1 1999 DEP DWM laboratory QA/QC blank data for organics in fish tissue.
Table A5.4.2 1999 DEP DWM Merrimack River Basin laboratory QA/QC data for metals in fish tissue.
Table A5.4.3 1999 DEP DWM laboratory QA/QC lab fortified blank data for organics in fish tissue.
Table A5.4.4 1999 DEP DWM laboratory QA/QC duplicate data for organics in fish tissue.
Table A5.4.5 1999 DEP DWM laboratory QA/QC lab fortified matrix and matrix spike duplicate data for organics in fish tissue.
Table A5.5.1 1994 Fish Tissue Analytical Methods and MDLs.
Table A5.5.2 1994 DEP OWM laboratory QA/QC data for metals in fish tissue.
Table A5.5.3 1994 DEP OWM laboratory QA/QC blank data for organics in fish tissue.
Table A5.5.4 1994 DEP OWM laboratory QA/QC duplicate data for organics in fish tissue.
Table A5.5.5 1994 DEP OWM laboratory QA/QC lab fortified matrix data for organics in fish tissue.

APPENDIX B - 1999 DEP DWM MERRIMACK RIVER BASIN SURVEY DATA

Table B1. 1999 Merrimack River Basin Survey DEP DWM sampling matrix.
Table B2. Aquatic macrophytes observed by DEP DWM in 1999 in Massapoag, Newfield and Flint ponds.
Table B3. 1999 DEP DWM Merrimack River Basin, , *in-situ* Hydrolab® data.
Table B4. 1999 DEP DWM Merrimack River Basin inlake Secchi depth, alkalinity, color, total phosphorus and chlorophyll *a* data.
Table B5. 1999 DEP DWM fish toxics monitoring data for Chadwicks Pond, Haverhill/Boxford.
Table B6. 1999 DEP DWM fish toxics monitoring data for Lake Cochichewick, North Andover.
Table B7. 1999 DEP DWM fish toxics monitoring data for Johnsons Pond, Groveland/Boxford.
Table B8. 1994 DEP OWM fish toxics monitoring data for the Merrimack River in Lawrence and Lowell.

Figure B1. Locations of 1999 DEP DWM fish contaminant monitoirng stations (Chadwicks Pond – F0066, Johnsons Pond – F0067, Lake Cochichewick F0069) in the Merrimack River Basin.
Figure B2. Locations of 1994 DEP OWM fish contaminant monitoring stations on the Merrimack River.

APPENDIX C - TECHNICAL MEMORANDUM (TM-84-4) MERRIMACK RIVER WATERSHED 1999 BIOLOGICAL ASSESSMENT

Table 1. List of macroinvertebrate biomonitoring stations sampled during the 1999 Merrimack River watershed survey, including station identification number, drainage area, station description, and sampling date.
Table 2. List of perceived problems addressed during the 1999 Merrimack River watershed biomonitoring survey.

Figure 1. Location of DWM biomonitoring stations for the 1999 Merrimack River watershed survey.

APPENDIX D – SUMMARY OF NPDES AND WMA PERMITTING INFORMATION, MERRIMACK RIVER BASIN

Table D1. Merrimack River Basin Municipal Surface Wastewater Discharges.
Table D2. Merrimack River Basin Industrial Treatment Plants.
Table D3. List of WMA registered and permitted average annual water withdrawals in the Merrimack River Basin.

APPENDIX E - DMF SHELLFISH DATA, MERRIMACK RIVER BASIN

Table E1. DMF Shellfish Management Program Managed Shellfish Growing Area Classifications.
Table E2. DMF - Shellfish Project Classification Area Information as of October 2000.

APPENDIX F - DEP 1999 GRANT AND LOAN PROGRAMS

APPENDIX G – DEP/WES MERRIMACK RIVER MICROBIAL INDICATOR STUDY 1999-2001

Table G1. Bacteriological data extracted from the Microbial Indicator Study.

APPENDIX A – DATA VALIDATION REPORT FOR 1999 DEP/DWM MERRIMACK WATERSHED MONITORING DATA

PREFACE:

The objective of DWM data validation is to provide final, usable data, based on a thorough review of draft data and associated field and laboratory quality control information. This report includes evaluation of all 1999 data, as well as previously unreported 1994 fish toxics data, collected in the Merrimack watershed.

This Appendix is divided into seven sections as follows:

- A1. Introduction
- A2. Data Validation Process for 1999 DWM Data
- A3. 1999 QAPPs/SOPs Used in Merrimack Watershed Monitoring
- A4. 1999 QA/QC Acceptance Criteria for Merrimack Watershed Data
- A5. QC Sample Data and Validation Decisions for 1999 (and 1994 fish toxics) Merrimack Watershed Data
- A6. 1999 Analytical Methods and MDLs
- A7. Conclusions

A1. INTRODUCTION

The following data were collected in 1999 as part of the DEP/DWM Merrimack watershed assessment:

- *In –situ* Hydrolab readings and fish tissue toxics data at three lakes.
- Discrete water quality data and Hydrolab readings at three lakes, and
- Benthic macroinvertebrates and aquatic habitat assessment at a total of four river/stream stations

For specific monitoring locations, parameters and dates, see Table B1 in Appendix B.

A2. THE DATA VALIDATION PROCESS FOR 1999 DWM DATA

The procedures used to accept, accept with qualification or censor data are based on the draft DWM SOP for data validation (July, 2001), and are in addition to separate quality assurance activities and laboratory validation performed by WES.

The specific criteria applied to the 1999 DWM data include:

- Conformance to DWM-project and DWM-programmatic Quality Assurance Project Plans (QAPPs) and Standard Operating Procedures (SOPs)

- Precision (review of overall precision, including field precision and lab precision)

- Accuracy (review of lab quality control data regarding analysis of blind performance evaluation samples, internal check standards, blanks and matrix spike samples)

- Representativeness (review of field data sheets and field SOPs used to collect the data for the evidence of the potential for non-representative conditions at the time of sampling)

- Holding Times and Preservation (review for conformance to method holding times and preservation requirements for samples)

- Frequency of Field QC samples (review for conformance to standard DWM requirements for the number of field blank and split/duplicate samples taken per total number of samples taken)

- Contamination of Field Blanks (review of blank analyses for detectable analyte concentrations)

- Completeness (review of the amount of usable data in comparison to that intended to be collected)

- Chain-of-Custody (review of sample handling and transfer records)

Completion of 1999 data validation has resulted in the entry of "final" environmental data into the DWM database system. Data that fell outside established QA/QC acceptance criteria were investigated and may have been subject to censoring or qualification.

Specific symbols and qualifiers used to censor and qualify data are provided in Table A2.

Table A2.1.1. 1999 Data Symbols and Qualifiers

Symbol/ Qualifier	Data Source	Definition
**	All	Censored or missing data
--	All	No data
<mdl	All	Less than method detection limit (MDL). Denotes a sample result that went undetected using a specific analytical method. The actual, numeric MDL is typically specified (eg. <0.2).
c	Hydrolab	Greater than **c**alibration range for conductivity (>718, 1413, 2760, 6668 or 12,900 uS/cm) or turbidity (> 10, 20 or 40 NTUs), depending on calibration standard used, or outside acceptable range about calibration standard. Also used for calculated TDS and Salinity readings that are based on qualified conductivity readings.
i	Hydrolab	**i**naccurate readings from Hydrolab multiprobe likely; may be due to significant pre-survey calibration problems, post-survey calibration readings outside typical acceptance range for the low ionic check and for the deionized blank water check, or lack of calibration of the depth sensor prior to use.
m	Hydrolab	**m**ethod not followed; one or more protocols contained in the DWM Hydrolab SOP not followed, ie. operator error (eg. less than 3 readings per station (rivers) or per depth (lakes), or instrument failure not allowing method to be implemented.
s	Hydrolab	Field **s**heet recorded data were used to accept data, not data electronically recorded in the Hydrolab surveyor unit, due to operator error or equipment failure.
u	Hydrolab	**u**nstable readings, due to lack of sufficient equilibration time prior to final readings, non-representative location, highly-variable water quality conditions, etc.
?	Hydrolab	Light interference on Turbidity sensor (Hydrolab error message). Data is typically censored.
a	Discrete samples	**a**ccuracy as estimated at WES Lab via matrix spikes, PT sample recoveries, internal check standards and lab-fortified blanks did not meet project data quality objectives identified for program or in QAPP.
b	Discrete samples	**b**lank Contamination in lab reagant blanks and/or field blank samples (indicating possible bias high and false positives).
d	Discrete samples	Precision of field **d**uplicates (as RPD) did not meet project data quality objectives identified for program or in QAPP.
e	Discrete samples	not theoretically possible (e.g., when a specific Secchi depth is greater than the reported station depth)
f	Discrete samples	**f**requency of quality control duplicates did not meet data quality objectives identified for program or in QAPP.
h	Discrete samples	**h**olding time violation (usually indicating possible bias low)
j	Discrete samples	'estimated' value; used for lab-related issues where certain lab QC criteria are not met and re-testing is not possible (as identified by the WES lab only). Also used by WES to report sample data where the sample concentration is less than the 'reporting' limit or RDL and greater than the method detection limit or MDL (mdl< *x* <rdl). Also used to note where values have been reported at levels less than the MDL.
m	Discrete samples	**m**ethod SOP not followed or fully implemented, due to complications with sample matrix (eg. sediment in sample, floc formation), lab error (eg. cross-contamination between samples), or additional steps taken by the lab to deal with matrix complications.
p	Discrete samples	Samples not **p**reserved per SOP or analytical method requirements.
r	Discrete samples	Samples collected not **r**epresentative of actual field conditions.

A3. 1999 QAPPS/SOPS USED IN MERRIMACK WATERSHED MONITORING

Quality assurance and quality control (QA/QC) documents in place and/or activities performed before, during and after 1999 Merrimack watershed monitoring included:

- Production of a 1999 Quality Assurance Project Plan (QAPP) for fish contaminant monitoring (now CN 13.0)
- Production of a 1999 QAPP for benthic macroinvertebrate collection (now CN 7.0)
- Production of a 1999 QAPP for Lakes Baseline TMDL assessments (CN 22.0)
- Production of an SOP for grab sample collection (CN 1.0). This included the use of bucket samplers (this technique has been discontinued).
- Implementation of field and lab quality control procedures, including that for Hydrolab multiprobe use (now CN 4.0) and fish collection/preparation for fish tissue analysis (now CN 40.0)
- On-going coordination with the WES laboratory regarding sample delivery, analysis and reporting
- Post-monitoring data review and assessment.

A detailed summary of data validation for all 1999 DWM data (ie. all the "yellow" basins) can be found in the 1999 Data Validation Report (MA DEP 2001a).

A4. 1999 QA/QC ACCEPTANCE CRITERIA FOR MERRIMACK WATERSHED DATA

A4.1 QA/QC Objectives and Criteria for 1999 *In-Situ* Hydrolab Multi-probe Data

Trained DWM staff members conducted *in-situ* measurements using a Hydrolab® Series 3 Multiprobe instrument that simultaneously measures dissolved oxygen, temperature, pH, conductivity, and depth, and provides calculated estimates for total dissolved solids/salinity, and % saturation of oxygen.

To ensure the quality of the Merrimack data, the following QA/QC steps were taken:

- Pre- Survey Calibration and Check: Standard pre-survey calibration of the Hydrolab unit was conducted in accordance with the DWM SOP for Hydrolab use. After the instrument was calibrated and before the instrument was released to field staff, an instrument check using both a low ionic standard and filtered de-ionized water was performed. The purpose of this check is to make sure that the instrument is providing stable readings as the waters in Massachusetts are typically of low ionic strength. If the instrument failed acceptance criteria, it was not released to field staff until the source of error was identified and corrected.

- Post Survey Check: A standard post survey check of the Hydrolab unit was performed in accordance with the DWM SOP for Hydrolab use. Upon return of the Hydrolab unit to DWM's lab after a survey run, a visual inspection was performed to identify any physical damage that may have occurred in the field. The calibration of the unit was then checked against both a low ionic standard and filtered de-ionized water. The results of the post survey calibration check were compared to the pre-calibration results. If visual damage was observed and/or post calibration acceptance criteria were not achieved, the source of error was investigated and data collected in the field may have been subject to qualification or censoring.

- Data Reduction: The Hydrolab Coordinator and Database Manager reviewed the Hydrolab data for instability, instrument malfunction, operator error and aberrant trends. If any of these conditions were detected, the data were further investigated and may have been recommended for qualification or censoring. Measured data are specifically evaluated for the following:

• Consistency with the Hydrolab SOP (specifically, the requirement for three (minimum)-five (preferred) sequential readings one-minute-apart at appropriate depths, proper field use, etc.).

• Accuracy and precision of readings, as assessed through review of pre-survey calibration/check and post-survey check data, as well as field notes for any information on faulty operation and/or unusual field conditions.

• Representativeness of data (review of fieldsheets and notes for any information that might indicate non-representativeness; eg. not taken at the deep hole).

• Check for "outliers" or unreasonable data, based on best professional judgement. Outliers are identified and flagged for scrutiny. For lake depth profiles, it is recognized that thermal stratification can cause rapid changes in Hydrolab parameters within the thermocline, often resulting in unstable readings (typically qualified with "U").

• In lieu of verifying in the electronic record that the Hydrolab was depth-calibrated prior to use, both general and specific criteria are used to accept, qualify or censor of Hydrolab Depth readings, as follows: General Depth Criteria: Apply to each OWMID#; For negative and zero depth readings: Censor (i), (likely in error); for 0.1 m depth readings: Qualify (i), (potentially in error); and for 0.2 and greater depth readings: Accept without qualification, (likely accurate). Specific Depth Criteria: Apply to entirety of depth data for survey date. If zero and/or negative depth readings occur more than once per survey date, censor all negative/zero depth data, and qualify all other depth data for that survey (indicates that erroneous depth readings were not recognized in the field and that corrective action (field calibration of the depth sensor) was not taken, ie. that all positive readings may be in error.).

• The criterion used in 1999 to accept, qualify or censor Conductivity (and the dependent, calculated estimates for TDS and Salinity) readings was based on exceedance of the calibration standard concentration. For exceedances greater than two times the standard, the conductivity reading was typically censored. Readings were qualified for exceedances less than two times the calibration standard. In cases where readings fell far below the calibration standard concentration (eg. measured value of 100 uS/cm using 6668 calibration standard), no censoring or qualification was imposed.

• For D.O. values less than 0.2 mg/l, 1999 data were accepted without qualification and reported as "<0.2". Similarly, percent DO saturation was reported as "<2%" when DO values were <0.2 mg/l.

• Total dissolved solids (TDS) values were calculated from conductivity readings using a multiplier of 0.64. Percent oxygen saturation values were calculated by comparing ambient D.O. readings to saturation values.

A4.2 QA/QC Objectives and Criteria for 1999 Discrete Water Sample Data

The collection and analysis of discrete water samples from the Merrimack watershed followed the DWM Standard Operating Procedure for grab sampling (CN# 1.0) and analyte-specific WES SOPs. Using the following criteria, as well as other considerations and input from data reviewers, individual datum were accepted, accepted with qualification or censored. In cases where poor quality control (eg. blank/cross contamination) affected batched analyses or entire surveys, censoring/qualification decisions were applied to groups of samples (eg. a specific crew's samples, a specific survey's samples or all samples from a specific batch analysis).

- Sampling/Analysis Holding Time: Each analyte has a standard holding time that has been established to ensure sample/analysis integrity. Refer to DWM Standard Operating Procedure CN# 1.1 for a complete listing. If the standard holding time was exceeded, this criterion is violated and the data may be censored, depending on the extent of exceedance. For very minor exceedances (eg. < than 10% of the holding time), the data is typically qualified ("H" for minor holding time violation).

- Quality Control Sample Frequency: At a minimum, one field blank and one replicate must be collected for every ten samples by any given sampling crew on any given date. If less than 10% blanks and/or replicates were collected, the data may be censored or qualified, based on a review of crew member experience, training and history, as well as other factors relevant to the specific survey.
- Field Blanks: Field blanks were prepared at the DWM Worcester Laboratory. Reagent grade water was transported into the field in a sample container where it was transferred into a different sample container and fixed where necessary using the same method as its corresponding field sample. All blanks were submitted to the WES laboratory "blind". If the field blank results were greater than the MDL, the data may be censored or qualified, depending on extent and other factors.

- Field Replicates: In 1999, field replicate samples were taken as "split" samples, where two independent samples were created from a larger volume sample (not sequential duplicates or co-located duplicates). Both samples were submitted to WES laboratory "blind". In order for this data quality criterion to be met, the results must generally be:

- <20% Relative Percent Difference (RPD) for method detection limits >1mg/L, or
- <30% RPD for method detection limits <1mg/L.

or meet more specific criteria contained in a 1999 QAPP. If the criteria are not met, the data may be censored or qualified, depending on extent of exceedance and other factors. In most cases, poor precision of field split samples reflects potential poor reproducibility for entire surveys and/or analytical batch runs, and may lead to the censoring/qualification of same.

- Laboratory assessment of analytical precision and accuracy: The WES Laboratory is solely responsible for the administration of its Quality Assurance Program and Standard Operating Procedures. WES staff release discrete water sample data when their established QA/QC criteria have been met. When the following criteria cannot be met, data are qualified as "estimated" (using a "J" value) if appropriate, or no data ("ND") is reported:

- Low Calibration Standards – Checks the stability of the instrument's calibration curve; analyzes the *accuracy* of an instrument's calibration within a 5% range.

- Reference Standards – Generally, a second source standard (a standard different from the calibration stock standard) that analyzes the method *accuracy*.

- Laboratory Reagent Blank/Method Blank (LRB) – Reagent grade water (de-ionized) extracted with every sample set used to ensure that the system is free of target analytes (< MDL) and to assess potential blank contamination.

- Duplicate Sample – Measures the *precision* (as Relative Percent Difference or RPD) of the analytical process. The acceptable laboratory %RPD range is typically ≤ 25%.

- Spike Sample (Laboratory Fortified Blank - LFB, Laboratory Fortified Matrix - LFM) – Measures the *accuracy* (% Recovery) of an analytical method. The acceptable laboratory % recovery range is typically between 80 – 120% for LFB samples and 70 –130% for LFM discrete water samples.

A4.3 QA/QC Objectives and Criteria for 1999 (and 1994) Fish Tissue Contaminant Data

Fish from the Merrimack watershed were collected and processed according to the DWM 1999 Standard Operating Procedure (SOP) for fish contaminant monitoring (now CN 40.0). This SOP adheres to EPA-approved laboratory QA/QC methodologies (EPA 823-R-95-007). Laboratory data quality was assessed at WES by analyzing the following quality control samples:

- Laboratory Reagent Blank/Method Blank (LRB) – Clean clam tissue matrix extracted with every sample set to ensure that the system is free of target analytes (< MDL) and to assess the potential for blank contamination.

• Laboratory Fortified Blank (LFB) – Clean clam tissue matrix spiked with a low concentration of target compounds. LFB results are used to establish *accuracy* of system's performance. The acceptable laboratory % recovery range is typically 80 – 120%.

• Laboratory Fortified Matrix (LFM) – Tissue matrix spiked with a low concentration of a target compound. LFM and LFM duplicate results are used to establish *accuracy* of the extraction and analytical process. The acceptable laboratory % recovery range is typically between 70 – 130% for metal analysis and 60 –140% for PCB/Organochlorine Pesticide analysis.

• Quality Control Standard (QCS) – A pre-spiked secondary tissue sample. QCS results are used to establish *accuracy* in the extraction and test methods. The acceptable laboratory % recovery range is typically between 80–120%.

• Laboratory sample duplicates – A second lab sample is taken the blended fish tissue slurry for analysis of all analytes. Used to estimate analytical precision, the acceptable laboratory relative percent difference (RPD) for lab duplicates is typically 80-120%.

A4.4 QA/QC Objectives of 1999 Data for Benthic Macroinvertebrates, Aquatic Habitat and Miscellaneous Biological Monitoring (periphyton, aquatic macrophytes, phytoplankton, etc.)

Macroinvertebrate sampling and processing was conducted by DWM biologists, as described in the SOP *Water Quality Monitoring In Streams Using Aquatic Macroinvertebrates* (now 39.0), which is based on US EPA Rapid Bioassessment Protocols (RBP III). The QAPP for 1999 biomonitoring outlined general QC steps that included:

• Thorough rinsing of sampling equipment between stations to prevent inter-station effects.
• Duplication and checking (for transcription errors) of documentation and database entries.
• In-house spot-checking (among two DWM biologists) of taxa identifications for accuracy.

A5. QC SAMPLE DATA AND VALIDATION DECISIONS FOR 1999 (AND 1994 FISH TOXICS) MERRIMACK WATERSHED DATA

Data validation procedures, as now outlined in DWM's draft Data Validation SOP (draft, 2001; CN 56.0) were applied to in-situ Hydrolab, discrete water quality and fish tissue data (1994 and 1999) for the Merrimack watershed. The 1999 Data Validation Report (MADEP 2000a) summarizing 1999 DWM monitoring QA/QC results is also available as a separate evaluation of all 1999 data.

Assessment and validation of the benthic macroinvertebrate, periphyton and habitat data collected for the Merrimack watershed is not covered here. DWM QA/QC assessment of benthic/habitat data is typically more general in nature (ie. adherence to the SOP and QAPP, discussions with primary staff on QAPP implementation, etc.).

A5.1 Hydrolab Data Validation

Review of 1999 Hydrolab data and imposition of the data acceptance criteria identified in A4.1 resulted in specific validation decisions (censored, qualified or accepted without qualification), as follows in Table A5.1.1. All other data were accepted. See the 1999 Data Validation Report appendix for the complete Hydrolab QC records.

Table A5.1.1. 1999 DEP DWM Censored/Qualified Hydrolab Data

Survey Date(s)	Waterbody	Censored/ Qualified Hydrolab Parameters	Censored/ Qualified	Reason and/or Clarification
5/6/99	Johnsons Pond	NA	NA	Accept Record # 4994 for 5.9 m depth data (not #4995)
5/17/99	Lake Cochichewick	NA	NA	Accept Record # 5153 for 3.7 m depth data (not #5154)
7/13/99	Newfield Pond	NA	NA	Accept Record # 799 for 5.5 m depth data (not #800)
7/13/99	Newfield Pond	Temperature at 3.5, 4.5 and 6.5 m depths	Qualify (u)	Unstable readings
9/7/99	Newfield Pond	Temp at 5.5 m D.O. and % SAT at 3.5 m	Qualify (u) Qualify (u)	Unstable readings
4/21/99	Chadwicks Pond	D.O., temp, cond, pH, % saturation, depth and TDS	Qualify (m)	Only one reading per depth
7/14/99	Massapoag Pond	D.O. and % SAT at 3.5 m depth	Qualify (u)	Unstable readings
8/11/99	Massapoag Pond	Temp at 4.7, 7.5 and 8.5 m	Qualify (u)	Unstable readings
9/9/99	Massapoag Pond	Temp at 4.5 and 8.4 m D.O. and % SAT at 4.5 and 6.2 m	Qualify (u) Qualify (u)	Unstable readings

A5.2 Discrete Sample Data Validation

Field blank and field replicate sampling results for discrete water quality sample data are provided in Tables A.5.2.1 and A5.2.2. DEP DWM QA/QC water quality data is managed and maintained in the *Water Quality Data Access Database*.

Table A5.2.1. 1999 DEP DWM inlake physico-chemical QA/QC field blank data. (All units expressed in mg/L unless otherwise specified.)

Date	OWMID	OWMID QA/QC	Alkalinity (mg/L)	Color (PCU)	Total Phosphorus (mg/L)
Field Blank Samples					
08/03/99	LB-0078	BLANK	<2.0	<15	<0.005
09/29/99	LB-0229	BLANK	--	--	<0.005
08/05/99	LB-0105	BLANK	<2.0	<15	<0.005
09/28/99	LB-0405	BLANK	<2.0	<15	<0.005
08/31/99	LB-0380	BLANK	<2.0	<15	<0.005
09/29/99	LB-0234	BLANK	<2.0	--	--
07/29/99	LB-0053	BLANK	<1.0	<15**d**	<0.005
08/25/99	LB-0203	BLANK	<2.0	<15**d**	<0.005
09/23/99	LB-0354	BLANK	<2.0	<15	<0.005
08/04/99	LB-0096	BLANK	<2.0	<15	<0.005
09/01/99	LB-0241	BLANK	<2.0	<15	<0.005
10/05/99	LB-0390	BLANK	<2.0	<15	<0.005
09/02/99	LB-0256	BLANK	<2.0	<15	<0.005
07/28/99	LB-0065	BLANK	<1.0	<15**d**	<0.005
08/26/99	LB-0216	BLANK	<2.0	<15	<0.005
09/22/99	LB-0365	BLANK	<2.0	<15	<0.005
08/05/99	LB-0415	BLANK	<2.0	<15	<0.005
08/12/99	LB-0187	BLANK	--	--	<0.005

** =mssing/censored data

-- = no data (no sample collected)

QUALIFIERS: **d** = precision of field duplicate did not meet project data quality objectives; **m** = field and/or lab SOPs not followed or lost/unanalyzed samples

Table A5.2.1. Continued. 1999 DEP DWM inlake physico-chemical QA/QC field blank data. (All units expressed in mg/L unless otherwise specified.)

Date	OWMID	OWMID QA/QC	Alkalinity (mg/L)	Color (PCU)	Total Phosphorus (mg/L)
Field Blank Samples					
07/15/99	LB-0029	BLANK	<2.0	<15**d**	<0.005
08/12/99	LB-0183	BLANK	--	--	<0.005
09/13/99	LB-0329	BLANK	<2.0	<15	<0.005
07/27/99	LB-0041	BLANK	<1.0	<15	<0.005
08/24/99	LB-0191	BLANK	<2.0	<15**d**	<0.005
09/21/99	LB-0341	BLANK	<2.0	<15	<0.005
07/14/99	LB-0023	BLANK	<2.0	<15	<0.005
08/11/99	LB-0171	BLANK	<1.0	<15	<0.005
09/09/99	LB-0316	BLANK	<2.0	--	<0.005
07/13/99	LB-0003	BLANK	2.0	**m	<0.005
08/10/99	LB-0153	BLANK	<1.0	<15	<0.005
09/07/99	LB-0304	BLANK	<2.0	--	<0.005
09/13/99	LB-0281	BLANK	<2.0	<15	<0.005
08/11/99	LB-0120	BLANK	--	--	<0.005
09/15/99	LB-0267	BLANK	<2.0	--	<0.005

** = missing/censored data

-- = no data (no sample collected)

QUALIFIERS: **d** = precision of field duplicate did not meet project data quality objectives; **m** = field and/or lab SOPs not followed or lost/unanalyzed samples

Table A5.2.2. 1999 DEP DWM inlake physico-chemical QA/QC field replicate data.

Date	OWMID	OWMID QA/QC	Alkalinity (mg/L)	Color (PCU)	Total Phosphorus (mg/L)
Mill Road Pond (Palis: 41032)					
Station: A	Description: deep hole, near dam at eastern end of pond, Brimfield.				
8/3/1999	LB-0076	LB-0077	18	55	0.023
8/3/1999	LB-0077	LB-0076	20	60	0.020
Relative Percent Difference (RPD):			*10.5%*	*8.7%*	*14.0%*
9/29/1999	LB-0226	LB-0227	13	--	0.025
9/29/1999	LB-0227	LB-0226	11	--	0.026
Relative Percent Difference (RPD):			*16.7%*		*3.9%*
Morse Pond (Palis: 41033)					
Station: A	Description: deep hole near outlet at southern end , Southbridge.				
8/5/1999	LB-0103	LB-0104	15	50	0.12
8/5/1999	LB-0104	LB-0103	15	46	0.14
Relative Percent Difference (RPD):			*0.0%*	*8.3%*	*15.4%*
9/28/1999	LB-0403	LB-0404	9.0	41	0.017
9/28/1999	LB-0404	LB-0403	9.0	44	0.018
Relative Percent Difference (RPD):			*0.0%*	*7.1%*	*5.7%*
Sherman Pond (Palis: 41046)					
Station: A	Description: deep hole in northeast quadrant of pond, Brimfield.				
8/31/1999	LB-0378	LB-0379	**m	38	0.022
8/31/1999	LB-0379	LB-0378	12	29	0.021
Relative Percent Difference (RPD):				*26.9%*	*4.7%*
Sibley Pond (Palis: 41047)					
Station: A	Description: North Basin, deep hole at southern end, Charlton.				
7/29/1999	LB-0051	LB-0052	25**d**	17**d**	0.030
7/29/1999	LB-0052	LB-0051	15**d**	31**d**	0.030
Relative Percent Difference (RPD):			*50.0%*	*58.3%*	*0.0%*
8/25/1999	LB-0201	LB-0202	20	44**d**	0.050
8/25/1999	LB-0202	LB-0201	19	25**d**	0.048
Relative Percent Difference (RPD):			*5.1%*	*55.1%*	*4.1%*

** = missing/censored data; -- = no data (no samples collected); QUALIFIERS: **d** = precision of field duplicate did not meet project data quality objectives; **m** = field and/or lab SOPs not followed or lost/unanalyzed samples

Table A5.2.2. Continued. 1999 DEP DWM inlake physico-chemical QA/QC field replicate data.

Date	OWMID	OWMID QA/QC	Alkalinity (mg/L)	Color (PCU)	Total Phosphorus (mg/L)
Sibley Pond (Palis: 41048)					
Station: A	Description: South Basin, deep hole close to center of pond, Charlton.				
9/23/1999	LB-0353	LB-0352	19	75	0.084
9/23/1999	LB-0352	LB-0353	18	70	0.088
Relative Percent Difference (RPD):			*5.4%*	*6.9%*	*4.7%*
Pierpont Meadow Pond (Palis: 42043)					
Station: A	Description: deep hole south of Charlton/Dudley border, Dudley.				
8/4/1999	LB-0094	LB-0095	12	17	****d**
8/4/1999	LB-0095	LB-0094	10	17	****d**
Relative Percent Difference (RPD):			*18.2%*	*0.0%*	
9/1/1999	LB-0238	LB-0239	11	29	0.022
9/1/1999	LB-0239	LB-0238	12	29	0.019
Relative Percent Difference (RPD):			*8.7%*	*0.0%*	*14.6%*
10/5/1999	LB-0388	LB-0389	11	23	0.027**d**
10/5/1999	LB-0389	LB-0388	11	22	0.016**d**
Relative Percent Difference (RPD):			*0.0%*	*4.4%*	*51.2%*
Rochdale Pond (Palis: 42048)					
Station: A	Description: deep hole in southeastem quadrant near outlet, Leicester.				
9/2/1999	LB-0254	LB-0255	14	46	0.028
9/2/1999	LB-0255	LB-0254	13	--	0.028
Relative Percent Difference (RPD):			*7.4%*		*0.0%*
Wallis Pond (Palis: 42062)					
Station: A	Description: deep hole, southern central lobe near dam, Dudley.				
7/28/1999	LB-0063	LB-0064	20	46**d**	0.021
7/28/1999	LB-0064	LB-0063	21	60**d**	0.022
Relative Percent Difference (RPD):			*4.9%*	*26.4%*	*4.7%*
8/26/1999	LB-0214	LB-0215	30	43	0.028
8/26/1999	LB-0215	LB-0214	31	31	0.028
Relative Percent Difference (RPD):			*3.3%*	*32.4%*	*0.0%*
9/22/1999	LB-0363	LB-0364	12	49	0.025
9/22/1999	LB-0364	LB-0363	14	60	0.025
Relative Percent Difference (RPD):			*15.4%*	*20.2%*	*0.0%*
Lower Mystic Lake (Palis: 71027)					
Station: B	Description: northwest quadrant of pond, Arlington/Medford.				
8/5/1999	LB-0416	LB-0417	54	<15	****d**
8/5/1999	LB-0417	LB-0416	56	--	****d**
Relative Percent Difference (RPD):			*3.6%*		
Ganawatte Farm Pond (Palis: 73037)					
Station: A	Description: deep hole, northern lobe of pond, Walpole				
7/15/1999	LB-0027	LB-0028	12	230**d**	0.030**d**
7/15/1999	LB-0028	LB-0027	13	120**d**	0.041**d**
Relative Percent Difference (RPD):			*8.0%*	*62.9%*	*31.0%*
8/12/1999	LB-0181	LB-0182	12	120**d**	****m**
8/12/1999	LB-0182	LB-0181	14	70**d**	****m**
Relative Percent Difference (RPD):			*15.4%*	*52.6%*	
9/13/1999	LB-0327	LB-0328	12	110**d**	0.034
9/13/1999	LB-0328	LB-0327	12	70**d**	0.035
Relative Percent Difference (RPD):			*0.0%*	*44.4%*	*2.9%*

** = missing/censored data; -- = no data (no samples collected); QUALIFIERS: **d** = precision of field duplicate did not meet project data quality objectives; **m** = field and/or lab SOPs not followed or lost/unanalyzed samples

Table A5.2.2. Continued. 1999 DEP DWM inlake physico-chemical QA/QC field replicate data

Date	OWMID	OWMID QA/QC	Alkalinity (mg/L)	Color (PCU)	Total Phosphorus (mg/L)
Turners Pond (Palis: 73059)					
Station: A	Description: deep hole in southeastern quadrant, Milton.				
7/27/1999	LB-0039	LB-0040	20	44	0.054
7/27/1999	LB-0040	LB-0039	21	40	0.053
	Relative Percent Difference (RPD):		*4.9%*	*9.5%*	*1.9%*
8/24/1999	LB-0189	LB-0190	23	<15**d**	0.038
8/24/1999	LB-0190	LB-0189	22	26**d**	0.037
	Relative Percent Difference (RPD):		*4.4%*	*53.7%*	*2.7%*
9/21/1999	LB-0339	LB-0340	19	29	0.048
9/21/1999	LB-0340	LB-0339	18	31	0.048
	Relative Percent Difference (RPD):		*5.4%*	*6.7%*	*0.0%*
Flint Pond (Palis: 84012)					
Station: A	Description: deep hole, center of eastern lobe, Tyngsborough.				
7/14/1999	LB-0020	LB-0022	28	50	0.025
7/14/1999	LB-0022	LB-0020	25	65	0.025
	Relative Percent Difference (RPD):		*11.3%*	*26.1%*	*0.0%*
8/11/1999	LB-0169	LB-0170	33	28**d**	0.021
8/11/1999	LB-0170	LB-0169	35	35**d**	0.021
	Relative Percent Difference (RPD):		*5.9%*	*22.2%*	*0.0%*
9/9/1999	LB-0314	LB-0315	36	--	0.017
9/9/1999	LB-0315	LB-0314	37	--	0.016
	Relative Percent Difference (RPD):		*2.7%*		*6.1%*
Newfield Pond (Palis: 84046)					
Station: A	Description: deep hole in southeastern quadrant near outlet, Chelmsford.				
7/13/1999	LB-0001	LB-0002	26	<15**m**	0.022
7/13/1999	LB-0002	LB-0001	26	17**m**	0.022
	Relative Percent Difference (RPD):		*0.0%*	*12.5%*	*0.0%*
8/10/1999	LB-0151	LB-0152	26	23	0.024
8/10/1999	LB-0152	LB-0151	27	23	0.024
	Relative Percent Difference (RPD):		*3.8%*	*0.0%*	*0.0%*
9/7/1999	LB-0302	LB-0303	27	--	0.020
9/7/1999	LB-0303	LB-0302	29	--	0.018
	Relative Percent Difference (RPD):		*7.1%*		*10.5%*
Ryder Pond (Palis: 96268)					
Station: A	Description: deep hole in northwest quadrant of pond, Truro.				
9/13/1999	LB-0279	LB-0280	<2.0	<15	0.008
9/13/1999	LB-0280	LB-0279	<2.0	<15	0.008
	Relative Percent Difference (RPD):		*0.0%*	*0.0%*	*0.0%*
Walkers Pond (Palis: 96331)					
Station: A	Description: deep hole, mid pond, Brewster.				
8/11/1999	LB-0118	LB-0119	--	--	0.074
8/11/1999	LB-0119	LB-0118	--	--	0.074
	Relative Percent Difference (RPD):				*0.0%*
9/15/1999	LB-0265	LB-0266	6.0	--	0.054
9/15/1999	LB-0266	LB-0265	8.0	--	0.054
	Relative Percent Difference (RPD):		*28.6%*		*0.0%*

** = missing/censored data; -- = no data (no samples collected); QUALIFIERS: **d** = precision of field duplicate did not meet project data quality objectives; **m** = field and/or lab SOPs not followed or lost/unanalyzed samples

A5.2.3 Censored/Qualified 1999 Merrimack Discrete Water Sample Data

Data censored, qualified or accepted without qualification are summarized below. All other data were accepted.

Table A5.2.3.1. 1999 DEP DWM Censored/Qualified Discrete Water Sample Data.

Watershed/ water body	Sample Date	OWMID #s	Analyte	Censored/ Qualified	Reason
Newfield Pond	8/10	LB-0155	TP	**Censor (m)**	Sample filtered after digestion, due to iron floc problem (current recommendation for this type of sample is not to filter)
Newfield Pond	7/13	LB-0005	TP	**Censor (m)**	Sample filtered after digestion, due to iron floc problem (current recommendation for this type of sample is not to filter)
Newfield Pond	7/13	LB-0001, 0002 and 0005	Color	Qualify (m)	Ambient field blank taken (LB-0003), but not analyzed or reported; survey run qualified
Newfield Pond	7/13	LB-0004	Chlorophyll a	Qualify (b)	Blank contamination due to poor lab procedures from 7/13-7/29 (corrected on 7/29)
Massapoag Pond	7/14	LB-0015	Chlorophyll a	Qualify (b)	Blank contamination (same as above)
Flint Pond	7/14	LB-0021	Chlorophyll a	Qualify (b)	Blank contamination (same as above)

A5.3 1999 Benthic Macroinvertebrate, Habitat Assessment and Fish Population Data

Based on review of the Merrimack River Watershed 1999 Biological Assessment (Appendix C) and discussions with DWM biologists, there was no reason found to censor or qualify any of the information gathered as part of the 1999 benthic/habitat/fish population surveys.

A5.4 1999 Merrimack Fish Toxics Data

DWM finds all 1999 fish tissue data from the Merrimack watershed to be acceptable and usable.

All fish tissue data passed QC acceptance limits of the WES laboratory and lab-validated data were reported by WES without qualification. Lab duplicate precision estimates for metals (Hg, Pb, Cd, As and Se) were 10% RPD or less. Lab accuracy estimates for metals using fortified blanks and QC samples ranged from 84 to 108 % recovery for all analytes. Lab accuracy estimates for metals using fortified sample matrix samples were slightly higher, ranging from 80 to 113 % recovery for all analytes.

Lab accuracy estimates for organic contaminants using lab-fortified blanks were generally within 80-120 % recovery for all analytes tested, with the following exceptions: Lab blanks spiked with PCB A1242 showed poor recovery (62%) and that for DDT was 128% recovery. All lab organics blanks showed non-detectable concentrations. Lab duplicate data for DDT and the congenor BZ#118 were acceptable. Lab fortified matrix samples using PCB arochlors and selected pesticides showed good recoveries, ranging from 94-120 % for LFM and LFM duplicates.

Although an extensive, external validation of 1999 fish tissue data was not performed, the results and conclusions contained in DWM's 1999 Fish Toxics Monitoring Public Request and Year 2 Watershed Surveys report are valid.

Three ponds (Lake Cochichewick, Johnsons Pond and Chadwicks Pond) in the Merrimack watershed were sampled for fish tissue contaminants in 1999 as part of the mercury research study conducted by DEP's Office of Research and Standards (ORS). This appendix does not include external validation of ORS study data from the Merrimack watershed.
Relevant QC information for 1999 fish toxics data are provided in the tables below. There were no field duplicate QC samples taken in 1999.

Table A5.4.1. 1999 DEP DWM laboratory QA/QC blank data for organics in fish tissue. The analytes were extracted and analyzed according to the modified AOAC 983.21 procedure for the analysis of PCB Aroclors and Congeners and Organochlorine Pesticides. (Data expressed in μg/g wet weight unless otherwise noted.)

DATE ANALYZED	LABORATORY SAMPLE NUMBER	ANALYTE		
		% Lipid	Pesticides	PCBs
2 December 1999	BLANK - 1	0.07	ND	ND
3 December 1999	BLANK - 2	0.09	ND	ND
7 December 1999	BLANK - 3	0.09	ND	ND
8 December 1999	BLANK - 4	0.08	ND	ND
9 December 1999	BLANK - 5	0.07	ND	ND
10 December 1999	BLANK - 6	0.09	ND	ND
14 December 1999	BLANK - 7	0.07	ND	ND
15 December 1999	BLANK - 8	0.15	ND	ND
16 December 1999	BLANK - 9	0.16	ND	ND
17 December 1999	BLANK - 10	0.10	ND	ND
21 December 1999	BLANK - 11	0.12	ND	ND
22 December 1999	BLANK - 12	0.09	ND	ND

ND - Not detected or the analytical result is at or below the established method detection limit (listed in section A6).

NOTE: Merrimack River Basin samples were batched with others. These laboratory QA/QC blank data for organics in fish tissue are pertinent to Merrimack River Basin samples.

Table A5.4.2. 1999 DEP DWM Merrimack River Basin laboratory QA/QC data for metals in fish tissue. (Data expressed in mg/Kg wet weight unless otherwise noted.)

		Precision			LFM Accuracy					Accuracy (% Recovery)			
Sample ID	Analyte	Sample	Duplicate	RPD	Spike Amount	Spike Recovered	Percent Spike Recovery (%) (WES LFM)	Sample Mean	LFM (spike + sample)	LFB	QCS	MDL	Analytical Method
L990113-10	Hg	0.57	0.59	3.4	2.0	2.14	107	0.580	2.72	106	107	0.02	EPA 245.6
L990113-20	As	<MDL	<MDL	NA	2.0	1.68	84	NA	NA	96	92	0.04	EPA 200.9
L990113-20	Se	0.073	0.081	10.4	2.0	2.22	111	0.077	2.30	97	93	0.04	EPA 200.9
L990113-20	Pb	<MDL	<MDL	NA	20	16.0	80	NA	NA	85	86	0.20	EPA 200.7
L990113-20	Cd	<MDL	<MDL	NA	20	17.8	89	NA	NA	84	88	0.020	EPA 200.7
L990113-22	Hg	1.28	1.31	2.3	2.0	2.26	113	1.295	3.56	108	105	0.02	EPA 245.6
L990140-2	Hg	0.40	0.41	2.5	2.0	1.78	89	0.405	2.19	100	96	0.02	EPA 245.6
L990142-5	Se	0.103	0.096	7.0	2.0	1.96	98	0.100	2.06	98	96	0.04	EPA 200.9
L990142-5	As	<MDL	<MDL	NA	2.0	1.60	80	NA	NA	101	93	0.04	EPA 200.9
L990142-5	Cd	<MDL	<MDL	NA	20	19.6	98	NA	NA	92	92	0.02	EPA 200.7
L990142-5	Pb	<MDL	<MDL	NA	20	16.4	82	NA	NA	80	93	0.20	EPA 200.7
L990166-19	Se	0.145	0.145	0	2.0	1.88	94	0.145	2.03	88	90	0.04	EPA 200.9
L990166-19	As	0.097	0.117	18.7	2.0	NA	*	0.107	NA	101	106	0.04	EPA 200.9
L990166-19	Pb	<MDL	<MDL	NA	20	18.0	90	NA	NA	92	95	0.20	EPA 200.7
L990166-19	Cd	<MDL	<MDL	NA	20	19.0	95	NA	NA	93	102	0.02	EPA 200.7

LFB - Laboratory Fortified Blank
LFM - Laboratory Fortified Matrix
MDL - Method Detection Limit
NR - Not Reported
QCS - Quality Control Sample
RPD - Relative Percent Difference
NA - Not Applicable
LFM Calculation: SA x %SR = SR ; SR + SM = LFM
* matrix interference; final concentration determined by method of standard additions

Table A5.4.3. 1999 DEP DWM laboratory QA/QC lab fortified blank data for organics in fish tissue. The analytes were extracted and analyzed according to the modified AOAC 983.21 procedure for the analysis of PCB Aroclors and Congeners and Organochlorine Pesticides. (Data expressed in µg/g wet weight unless otherwise noted.)

DATE ANALYZED	2 December 1999	7 December 1999	8 December 1999	14 December 1999	16 December 1999
LABORATORY SAMPLE NUMBER	Laboratory Fortified Blank #1	Laboratory Fortified Blank #2	Laboratory Fortified Blank #3	Laboratory Fortified Blank #4	Laboratory Fortified Blank #5
%LIPIDS	0.10	0.07	0.10	0.07	0.08
ANALYTE	PCB A1260 MDL 0.11	Chlordane MDL 0.11	PCB A1242 MDL 0.26	Toxaphene MDL 0.59	Lindane MDL 0.009 Heptachlor MDL 0.012 Aldrin MDL 0.016 DDT MDL 0.011
Spike Amount	0.96	0.98	1.0	0.96	Lindane 0.010 Heptachlor 0.010 Aldrin 0.010 DDT 0.020
Spike Recovered	0.95	1.0	0.67	0.91	Lindane 0.0098 Heptachlor 0.0115 Aldrin 0.0120 DDT 0.0255
Spike % Recovery	99	102	67	95	Lindane 98 Heptachlor 115 Aldrin 120 DDT 128

MDL – method detection limit
NOTE: Merrimack River Basin samples were batched with others. These laboratory QA/QC lab fortified blank data for organics in fish tissue are pertinent to Merrimack River Basin samples.

Table A5.4.4. 1999 DEP DWM laboratory QA/QC duplicate data for organics in fish tissue. The analytes were extracted and analyzed according to the modified AOAC 983.21 procedure for the analysis of PCB Aroclors and Congeners and Organochlorine Pesticides. (Data expressed in μg/g wet weight unless otherwise noted.)

DATE ANALYZED	LABORATORY SAMPLE NUMBER	ANALYTE		
		Pesticides*	PCBs*	% Lipid
3 December 1999	L990067-7	DDE 0.012 DDT 0.012	BZ# 118 0.0030	0.22
	L990067-7 duplicate	DDE 0.012 DDT 0.014	BZ# 118 0.0027	0.19
	relative percent difference	DDE 0% DDT 15.4%	BZ# 118 10.53%	15%
10 December 1999	L990178-24	ND	ND	0.20
	L990178-24 duplicate	ND	ND	0.23
	relative percent difference	NA	NA	14%
15 December 1999	L990212-3	ND	ND	0.63
	L990212-3 duplicate	ND	ND	0.63
	relative percent difference	NA	NA	0%

NA - not applicable
ND - not detected
* Fish tissue organic analytes (listed in Section A6) not appearing in the above table were included in the analysis and were not detected.
NOTE: Merrimack River Basin samples were batched with others. These laboratory QA/QC duplicate data for organics in fish tissue are pertinent to Merrimack River Basin samples.

Table A5.4.5. 1999 DEP DWM laboratory QA/QC lab fortified matrix and matrix spike duplicate data for organics in fish tissue. The analytes were extracted and analyzed according to the modified AOAC 983.21 procedure for the analysis of PCB Aroclors and Congeners and Organochlorine Pesticides. (Data expressed in μg/g wet weight unless otherwise noted.)

DATE ANALYZED	21 December 1999	21 December 1999	23 December 1999	23 December 1999
LABORATORY SAMPLE NUMBER	Matrix Spike L990227-2	Matrix Spike Duplicate L990227-2	Matrix Spike L990271-1	Matrix Spike Duplicate L990271-1
%LIPIDS	0.20	0.19	0.11	0.20
ANALYTE	PCB A1260 MDL 0.11	PCB A1260 MDL 0.11	Lindane MDL 0.009 Heptachlor MDL 0.012 Aldrin MDL 0.016 DDT MDL 0.011	Lindane MDL 0.009 Heptachlor MDL 0.012 Aldrin MDL 0.016 DDT MDL 0.011
SPIKE AMOUNT	1.14	1.14	Lindane 0.025 Heptachlor 0.025 Aldrin 0.025 DDT 0.050	Lindane 0.025 Heptachlor 0.025 Aldrin 0.025 DDT 0.050
SPIKE RECOVERED	1.08	1.07	Lindane 0.026 Heptachlor 0.024 Aldrin 0.026 DDT 0.052	Lindane 0.026 Heptachlor 0.027 Aldrin 0.028 DDT 0.060
SPIKE % RECOVERY	95	94	Lindane 104 Heptachlor 96 Aldrin 104 DDT 104	Lindane 104 Heptachlor 108 Aldrin 112 DDT 120

MDL – method detection limit
NOTE: Merrimack River Basin samples were batched with others. These laboratory QA/QC lab fortified matrix data for organics in fish tissue are pertinent to Merrimack River Basin samples.

A5.5 1994 Merrimack Fish Toxics Data

DWM finds all 1994 fish tissue data from the Merrimack watershed to be acceptable and usable. Users should take the age of the data into account; 1994 data may not represent present (2001) conditions.

All fish tissue data passed QC acceptance limits of the WES laboratory and lab-validated data were reported by WES without qualification. As for 1999 data, an extensive, external validation of 1994 fish tissue data was not performed.

Lab duplicate precision estimates for metals (Hg, Pb, Cd, As and Se) were generally 24% RPD or less, except for one sample for arsenic, where the RPD was 181% (.041 and <MDL). This sheds questions on the arsenic results for that batch run. Lab accuracy estimates for metals using lab-fortified blanks ranged from 75-132 % recovery, and for QC samples ranged from <MDL (Pb on two occasions) to 120 % recovery for all analytes. On two occasions, QC samples for Pb showed < MDL. This indicates that sample results for lead for the associated batches may have significant error. Lab accuracy estimates for metals using fortified sample matrix samples ranged from 72 to 127 % recovery for all analytes, except for one Se matrix sample at 64% recovery. All lab organics blanks showed non-detectable concentrations. Lab duplicate data showed non-detectable concentrations for all analytes tested. Lab fortified matrix sample spike/spike duplicate recovery using PCB arochlor 1260 was 146%, and that for lindane, heptochlor, aldrin and DDT were 63%, 91%, 109% and 64%, respectively. This indicates potential significant error in the associated batch analysis of lindane and DDT. Although the metals and organics data have been accepted without qualification, potential users of data involving poor quality control (as referenced above) are advised to consider the potential error in sample data for specific analytes.

Relevant QC information for 1994 fish toxics data are provided in the tables below. There were no field duplicate QC samples taken in 1994.

Table A5.5.1. 1994 Fish Tissue Analytical Methods and MDLs

Fish Tissue Analytes	EPA Method*	Method	MDLs
PCB Arochlor 1242		AOAC 983.21**	0.06 µg/g wet wt
PCB Arochlor 1254		"	0.17 µg/g wet wt
PCB Arochlor 1260		"	0.16 µg/g wet wt
Chlordane		"	0.11 µg/g wet wt
Toxaphene		"	0.11 µg/g wet wt
a-BHC		"	0.19 µg/g wet wt
b-BHC		"	0.09 µg/g wet wt
Lindane		"	0.16 µg/g wet wt
d-BHC		"	0.02 µg/g wet wt
Hexachlorocyclopentadiene		"	0.10 µg/g wet wt
Trifluralin		"	0.11 µg/g wet wt
Hexachlorobenzene		"	0.04 µg/g wet wt
Heptachlor		"	0.08 µg/g wet wt
Heptachlor Epoxide		"	0.59 µg/g wet wt
Methoxychlor		"	1.07 µg/g wet wt
DDD		"	0.13 µg/g wet wt
DDE		"	0.39 µg/g wet wt
DDT		"	0.25 µg/g wet wt
Aldrin		"	0.15 µg/g wet wt
Arsenic	EPA 200.9		0.040, 0.04,mg/kg 0.002 mg/L
Lead	EPA 239.1		1.0, 1.00 mg/kg 0.03, 0.05 mg/L
Lead	EPA 200.7A		0.05 mg/L
Selenium	EPA 270.2		0.04, 0.040 mg/kg 0.002 mg/L
Cadmium	EPA 213.1		0.01, 0.20, 0.03 mg/kg
Cadmium	EPA 200.7A		0.03mg/L
Mercury	EPA 245.1		0.0002 mg/L

* = "Methods for Chemical Analysis of Water and Wastes", Environmental Protection Agency, Environmental Monitoring Systems Laboratory – Cincinnati (EMSL-CI), EPA-600/4-79-020, Revised March 1983 and 1979 where applicable.

** = procedure for the analysis of PCB Aroclors and Congeners and Organochlorine Pesticides

Table A5.5.2. 1994 DEP OWM laboratory QA/QC data for metals in fish tissue. (Data expressed in mg/kg wet weight unless otherwise noted.)

		Precision			LFM Accuracy					Accuracy (% Recovery)			
Sample ID	Analyte	Sample	Duplicate	RPD	Spike Amount	Spike Recovered	Spike Recovery (%) (WES LFM)	Sample Mean	LFM (spike + sample)	LFB	QCS	MDL	Analytical Method
94-4636	As	<MDL	<MDL	NA	NR	NA	78	NA	NA	75	98	0.040	EPA 200.9
94-4636	Se	0.169	0.172	2	NR	NA	72	NA	NA	132	92	0.040	EPA 270.2
94-4636	Cd	<MDL	<MDL	NA	NR	NA	116	NA	NA	106	96	0.20	EPA 213.1
94-4636	Pb	<MDL	<MDL	NA	NR	NA	110	NA	NA	96	90	1.00	EPA 239.1
94-4254	As	<MDL	<MDL	NA	NR	NA	84	NA	NA	73	111	0.04	EPA 200.9
94-4254	Pb	<MDL	<MDL	NA	NR	NA	113	NA	NA	117	97	1.0	EPA 239.1
94-4254	Cd	<MDL	<MDL	NA	NR	NA	87	NA	NA	101	115	0.20	EPA 213.1
94-4254	Se	0.084	0.078	7	NR	NA	72	NA	NA	87	76	0.04	EPA 270.2
94-3967	Se	0.203	0.178	13	NR	NA	104	NA	NA	118	87	0.002	EPA 270.2
94-3967	As	0.041	<MDL	181	NR	NA	80	NA	NA	70	109	0.002	EPA 200.9
94-3967	Pb	<MDL	<MDL	NA	NR	NA	70	NA	NA	80	80	0.05	EPA 200.7A
94-3967	Cd	<MDL	<MDL	NA	NR	NA	110	NA	NA	80	100	0.03	EPA 200.7A
94-3613	As	<MDL	<MDL	NA	NR	NA	96	NA	NA	117	67	0.002	EPA 200.9
94-3613	Se	0.14	0.13	7	NR	NA	127	NA	NA	91	114	0.002	EPA 270.2
94-3613	Cd	<MDL	<MDL	NA	NR	NA	100	NA	NA	100	100	0.03	EPA 213.1
94-3613	Pb	<MDL	<MDL	NA	NR	NA	110	NA	NA	110	<MDL	0.05	EPA 239.1
94-2530	Se	<MDL	<MDL	NA	NR	NA	64	NA	NA	93	80	0.002	EPA 270.2
94-2529	As	<MDL	<MDL	NA	NR	NA	75	NA	NA	89	91	0.002	EPA 200.9
94-2529	Pb	<MDL	<MDL	NA	NR	NA	98	NA	NA	97	98	0.03	EPA 239.1
94-2529	Cd	<MDL	<MDL	NA	NR	NA	102	NA	NA	90	100	0.01	EPA 213.1
94-3064	As	<MDL	<MDL	NA	NR	NA	85	NA	NA	89	90	0.002	EPA 200.9
94-3064	Cd	<MDL	<MDL	NA	NR	NA	100	NA	NA	100	100	0.01	EPA 213.1
94-3064	Pb	<MDL	<MDL	NA	NR	NA	90	NA	NA	110	<MDL	0.03	EPA 239.1
94-3064	Se	0.09	0.09	0	NR	NA	118	NA	NA	92	80	0.002	EPA 270.2
94-3975	Hg	0.16	0.16	0	NR	NA	108	NA	NA	110	110	0.0002	EPA 245.1
94-4228	Hg	1.07	1.05	2	NR	NA	98	NA	NA	104	110	0.0002	EPA 245.1
94-3062	Hg	0.064	0.063	2	NR	NA	96	NA	NA	100	110	0.0002	EPA 245.1
94-3540	Hg	0.082	0.102	22	NR	NA	88	NA	NA	99	115	0.0002	EPA 245.1
94-4160	Hg	0.373	0.333	11	NR	NA	90	NA	NA	110	120	0.0002	EPA 245.1
94-4650	Hg	0.090	0.115	24	NR	NA	92	NA	NA	105	110	0.0002	EPA 245.1
94-2530	Hg	0.112	0.100	11	NR	NA	99	NA	NA	90	100	0.0002	EPA 245.1

LFB - Laboratory Fortified Blank
LFM - Laboratory Fortified Matrix
MDL - Method Detection Limit
NA - Not Applicable
NR - Not Reported
QCS - Quality Control Sample
RPD - Relative Percent Difference

LFM Calculation: SA x %SR = SR ; SR + SM = LFM

NOTE: Merrimack River Basin samples were batched with others. These laboratory QA/QC data for metals in fish tissue are pertinent to Merrimack River Basin samples

Table A5.5.3. 1994 DEP OWM laboratory QA/QC blank data for organics in fish tissue. The analytes were extracted and analyzed according to the modified AOAC 983.21 procedure for the analysis of PCB Aroclors and Congeners and Organochlorine Pesticides. (Data expressed in μg/g wet weight unless otherwise noted.)

DATE ANALYZED	LABORATORY SAMPLE NUMBER	ANALYTE		
		% Lipid	Pesticides	PCBs
15 February 1995	BLANK - 50	0.19	ND	ND
16 February 1995	BLANK - 51	0.26	ND	ND
17 February 1995	BLANK - 52	0.17	ND	ND

ND - Not detected or the analytical result is at or below the established method detection limit (listed in Table A5.5.1).
NOTE: Merrimack River Basin samples were batched with others. These laboratory QA/QC blank data for organics in fish tissue are pertinent to Merrimack River Basin samples

Table A5.5.4. 1994 DEP OWM laboratory QA/QC duplicate data for organics in fish tissue. The analytes were extracted and analyzed according to the modified AOAC 983.21 procedure for the analysis of PCB Aroclors and Congeners and Organochlorine Pesticides. (Data expressed in μg/g wet weight unless otherwise noted.)

DATE ANALYZED	LABORATORY SAMPLE NUMBER	ANALYTE		
		Pesticides*	PCBs*	% Lipid
16 February 1995	94-4164	ND	ND	1.1%
	94-4164 duplicate	ND	ND	1.1%
	relative percent difference	NA	NA	0%
17 February 1995	94-4653	ND	ND	0.68
	94-4653 duplicate	ND	ND	0.49
	relative percent difference	NA	NA	32

NA - not applicable
ND - not detected
* Fish tissue organic analytes (listed in Table A5.5.1) not appearing in the above table were included in the analysis and were not detected.
NOTE: Merrimack River Basin samples were batched with others. These laboratory QA/QC duplicate data for organics in fish tissue are pertinent to Merrimack River Basin samples.

Table A5.5.5. 1994 DEP OWM laboratory QA/QC lab fortified matrix data for organics in fish tissue. The analytes were extracted and analyzed according to the modified AOAC 983.21 procedure for the analysis of PCBs and Organochlorine Pesticides. (Data expressed in μg/g wet weight unless otherwise noted.)

DATE ANALYZED	14 February 1995	15 February 1995
LABORATORY SAMPLE NUMBER	Laboratory Spike - 29	Laboratory Spike - 30
%LIPIDS	0.35	0.22
ANALYTE*	PCB A1260 MDL 0.16	Lindane MDL 0.16 Aldrin 0.15 Heptachlor 0.08 DDT 0.25
SPIKE AMOUNT	NR	Lindane NR Aldrin NR HeptachlorNR DDT NR
SPIKE RECOVERED	NR	Lindane NR Aldrin NR HeptachlorNR DDT NR
SPIKE % RECOVERY	146	Lindane 63 Aldrin 109 Heptachlor 91 DDT 64

MDL – method detection limit
NR – not reported
* Fish tissue organic analytes (listed in Table A5.5.1) not appearing in the above table were included in the analysis and were not detected.
NOTE: Merrimack River Basin samples were batched with others. These laboratory QA/QC lab fortified matrix data for organics in fish tissue are pertinent to Merrimack River Basin samples.

A6. 1999 ANALYTICAL METHODS AND MDLS

Discrete Water Sample Analytes	EPA Method*	SM Methods**	Other Methods	MDLs
Chlorophyll *a* (DWM)		SM10200H		ND
Alkalinity		SM 2320B		1.0, 2, 2.0 mg/l
Phosphorus-P (Manual)		SM 4500P-E		0.01, 0.005 mg/l
Apparent Color (DWM)		SM2120B		15 pcu
Fish Tissue Analytes				
PCB Arochlor 1242			AOAC 983.21***	0.26 µg/g wet wt
PCB Arochlor 1254			"	0.37 µg/g wet wt
PCB Arochlor 1260			"	0.11 µg/g wet wt
Chlordane			"	0.11 µg/g wet wt
Toxaphene			"	0.59 µg/g wet wt
a-BHC			"	0.009 µg/g wet wt
b-BHC			"	0.011 µg/g wet wt
Lindane			"	0.009 µg/g wet wt
d-BHC			"	0.043 µg/g wet wt
Hexachlorocyclopentadiene			"	0.33 µg/g wet wt
Trifluralin			"	0.18 µg/g wet wt
Hexachlorobenzene			"	0.18 µg/g wet wt
Heptachlor			"	0.012 µg/g wet wt
Heptachlor Epoxide			"	0.015 µg/g wet wt
Methoxychlor			"	0.029 µg/g wet wt
DDD			"	0.011 µg/g wet wt
DDE			"	0.010 µg/g wet wt
DDT			"	0.011 µg/g wet wt
Aldrin			"	0.016 µg/g wet wt
BZ#81			"	0.0005 µg/g wet wt
BZ#77			"	0.0005 µg/g wet wt
BZ#123			"	0.0011 µg/g wet wt
BZ#118			"	0.0025 µg/g wet wt
BZ#114			"	0.0008 µg/g wet wt
BZ#105			"	0.0019 µg/g wet wt
BZ#126			"	0.0004 µg/g wet wt
BZ#167			"	0.0009 µg/g wet wt
BZ#156			"	0.0007 µg/g wet wt
BZ#157			"	0.0007 µg/g wet wt
BZ#180			"	0.0007 µg/g wet wt
BZ#169			"	0.0003 µg/g wet wt
BZ#170			"	0.0007 µg/g wet wt
BZ#189			"	0.0007 µg/g wet wt
Arsenic	EPA 200.9			0.04 mg/kg
Lead	EPA 200.7			0.20 mg/kg
Selenium	EPA 200.9			0.04 mg/kg
Cadmium	EPA 200.7			0.02 mg/kg
Mercury	EPA 245.6			0.02 mg/kg
In-Situ Water Quality Analytes				
Hydrolab® Multiprobe Series 3 analyzer (MA DEP 1999d)			DWM SOP (CN4.0)	Not Applicable

ND = no data

* = "Methods for Chemical Analysis of Water and Wastes", Environmental Protection Agency, Environmental Monitoring Systems Laboratory – Cincinnati (EMSL-CI), EPA-600/4-79-020, Revised March 1983 and 1979 where applicable.

** = Standard Methods, Examination of Water and Wastewater, 20th edition

*** = AOAC Official Methods of Analysis, 1990. (Samples were extracted and analyzed according to the modified AOAC 983.21 procedure for the analysis of PCB Aroclors and Congeners and Organochlorine Pesticides.)

A7. CONCLUSION

The Merrimack River watershed data collected in 1999 (and in 1994 for fish toxics) were reviewed with regard to project data quality objectives (DQOs) and adherence to DEP/DWM and WES Laboratory SOPs for collection and analysis. The primary DQO elements of precision, accuracy, representativeness, completeness and comparability (PARCC) were evaluated, as were associated quality control data.

With few exceptions, the precision and accuracy of sampling and analysis met performance criteria. Where exceptions occurred, there was often not enough justification to censor or qualify the data, and data were accepted without qualification. Where problems were significant for individual datum and/or for entire surveys or batched analyses, data were censored or qualified, as appropriate.

The 1999 Merrimack River watershed data is comparable with past and future data collected by DWM and others, based on the use of standardized methods and procedures. Although buckets were used as necessary for sample collection from drop locations in 1999, this technique has been discontinued. Use of the bucket method has been noted and, while its use may affect data quality for solids-related analytes (e.g., TSS, turbidity, nutrients, etc.), the 1999 Merrimack data is considered comparable to other data collected via other and current grab sampling methods.

REFERENCES

Clesceri, L.S., A.E. Greenberg, and A.D. Eaton, (editors). 1998. *Standard Methods for the Examination of Water and Wastewater 20th Edition*. American Public Heath Association, Washington, D.C.

MA DEP. 1990. *Biomonitoring Program Standard Operating Procedures 1990*. Department of Environmental Protection, Massachusetts Division of Water Pollution Control, Technical Services Branch. Westboro, MA.

MA DEP. 1995 January Draft. *Laboratory Quality Assurance Plan and Standard Operating Procedures*. Massachusetts Department of Environmental Protection, Division of Environmental Analysis, Senator William X. Wall Experiment Station. Lawrence, MA.

MA DEP. 1999. Open File. *1999 Hydrolab® QAQC*. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999a. CN 20.0 *QAPP for 1998 Water, Fish Tissue, Habitat and Biological Studies in the Blackstone River Watershed*, 3/30/99. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999b. CN 1.0 *Grab Collection Techniques for DWM Water Quality Sampling, Standard Operating Procedure*. October 25, 1999. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999c. CN 13.0 *Fish Contaminant Monitoring Program, Quality Assurance Project Plan, 1999*. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999d. CN 4.0 *Hydrolab® Series 3 Multiprobe, Standard Operating Procedure*. September 23, 1999. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 2000a. *1999 Data Validation Report*. CN 73.0; 9/2001. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

APPENDIX B - 1999 DEP DWM MERRIMACK RIVER BASIN SURVEY DATA

INTRODUCTION

The DWM began sampling in the Merrimack River Basin in April 1999 and, excluding June, continued through September 1999. Sampling components include macroinvertebrate and habitat quality evaluations in selected wadeable streams, fish sampling for organic and metal toxins in edible fillets, and baseline lake surveys, which included *in-situ* Hydrolab® Multiprobe Series 3 analyzer (hereafter referred to as Hydrolab®) measurements, alkalinity, color, total phosphorus, chlorophyll *a* sampling, and macrophyte identification/density at the maximum extent of growth. Each sampling component is described in the sections that follow.

BASELINE LAKE SURVEYS

Three of the 303(d) listed lakes in the Merrimack River Basin were selected for baseline surveys. Lakes were preferentially targeted for sampling based on the severity of the nutrient-related problem and the size of the lake (MA DEP 1999a). Those lakes that were listed solely for non-nutrient related issues (e.g., lakes listed for fish consumption advisories) and those with previous diagnostic/feasibility studies were not selected. Baseline surveys were conducted to provide information on the current chemical, physical and biological conditions of the lake system (i.e., in-lake and in the surrounding watershed).

Each baseline lake survey included a macrophyte survey conducted once during the late summer at the peak of macrophyte growth (generally in August/September). The survey data are used in several ways: 1) to determine if the macrophyte growth causes nuisance conditions such that the lake would be listed or delisted on the state's 303(d) list for violations of water quality standards; 2) to determine if the lake meets designed uses in the 305(b) assessments; 3) to monitor changes in density of plant growth following implementation of a TMDL; 4) to document invasive species distributions in the state; and 5) to suggest macrophyte management options for the lake.

Trophic status (an indicator of the productivity level of a lake) is based on the evaluation of data collected during baseline surveys. Parameters used to determine trophic status include; oxygen levels, chlorophyll *a* concentrations, total phosphorus levels, Secchi disk measurements, and macrophyte density determinations.

The data are also used to validate Total Maximum Daily Load (TMDL) phosphorus loading models and to document the present trophic conditions as well as assess the status of lake's designated uses. The total phosphorus data are used to evaluate accuracy of land use loading estimates (Mattson and Isaac 1999) of total phosphorus to lakes by comparing predictions of lake concentrations based on modeling to actual measured lake concentrations. These may be used to estimate internal loading or other unmeasured phosphorus sources. Concurrently, a lake database will be developed for both 303(d) development and for 305(b) evaluation based on lakes that are on the current 303(d) list. The data contained in this database along with the other data collected are used in TMDL development or to monitor lakes for changes in water quality and nuisance plant growth after TMDL implementation.

FISH TOXICS MONITORING

Fish toxics monitoring is aimed primarily at assessing human health risks associated with the consumption of freshwater fishes. The program is a cooperative effort between three MA DEP Offices/Divisions, (Watershed Management, Research and Standards, and Environmental Analysis), the Department of Fisheries and Wildlife Environmental Law Enforcement, and the Department of Public Health (MDPH). Fish tissue monitoring is typically conducted to assess the concentrations of toxic contaminants in freshwater fish, identify waterbodies where those concentrations may pose a risk to human health, and identify waters where toxic contaminants may impact fish and other aquatic life. Fish tissue analysis has been restricted to edible fillets. The fish toxics monitoring was designed to screen the edible fillets of several species of fish representing different feeding guilds (i.e., bottom dwelling

omnivores, top-level predators, etc.) for the presence of heavy metals (Pb, Cd, Se, Hg, As), PCB and organochlorine pesticides. These data are then used by the Massachusetts Department of Public Health in assessing human health risks associated with the consumption of freshwater fishes.

During September of 1994 fish toxics monitoring was conducted by MA DEP OWM (now MA DEP DWM) at two stations on the Merrimack River (Lowell and Lawrence). During April and May of 1999, as part of the ongoing fish toxics monitoring program and in support of an intensive mercury sampling program in northeastern Massachusetts designed by the MA DEP Office of Research and Standards (ORS), fish were sampled by MA DEP DWM at three sites in the Merrimack River Basin: Chadwicks Pond (a 161-acre pond in Haverhill/Boxford), Johnsons Pond (a 180-acre pond in Groveland/Boxford) and Lake Cochichewick (a 555-acre pond in North Andover).

BENTHIC MACROINVERTEBRATE STUDIES

Excerpted from *Merrimack River Watershed 1999 Biological Assessment* technical memorandum, which is attached as Appendix C of this Assessment Report.

> The main objectives of biomonitoring in the Merrimack River watershed were: (a) to determine the biological health of streams within the watershed by conducting assessments based on aquatic macroinvertebrate communities and habitat quality; and (b) to identify problem stream segments so that efforts can be focused on developing National Pollutant Discharge Elimination System (NPDES) permits, Water Management Act (WMA) permits, stormwater management measures, and control of other nonpoint source pollution. Specific tasks were:
>
> 1. Conduct benthic macroinvertebrate sampling and habitat assessments at selected locations throughout the Merrimack River watershed,
> 2. Based upon the macroinvertebrate data, identify river segments within the watershed with potential point/nonpoint source pollution problems, and
> 3. Using the benthic macroinvertebrate data and supporting water chemistry and field data:
>
>   - assess the types of water quality and/or water quantity problems that are present,
>   - if possible, make recommendations for remedial actions, and
>   - provide macroinvertebrate and habitat quality data to DWM's Environmental Monitoring and Assessment Program to be used in making aquatic life use assessments required by Section 305(b) of the Federal Clean Water Act (CWA).

MATERIALS AND METHODS

The DWM sampling plan matrix for the Merrimack River Basin is summarized in Table B1.

Table B1. 1999 Merrimack River Basin Survey DEP DWM sampling matrix.

WATERBODY	SEGMENT #	STATION(S)	April	May	July	August	September
Chadwicks Pond	MA84006	deep hole	H, T				
Lake Cochichewick	MA84008	deep hole		H, T			
Flint Pond	MA84012	A			C, F, H, N	C, F, H, N, P	C, F, H, N
Johnsons Pond	MA84027	deep hole		H, T			
Massapoag Pond	MA84087	A, B, C			C, F, H, N	C, F, H, N	C, F, H, N, P
Newfield Pond	MA84046	A			C, F, H, N	C, F, H, N, P	C, F, H, N
Stony Brook	MA84B-03	SB02			M		
Beaver Brook	MA84A-11	BB01			M		
Spicket River	MA84A-10	SR01			M		
Cobbler Brook	MA84A-22	CB01			M		

C=Chemistry (alkalinity, hardness, specific conductivity, chlorides, total solids, suspended solids, turbidity, color); **F**=Chlorophyll *a*; **H**= Hydrolab® multiprobe meter (pH, dissolved oxygen, conductivity, temperature, total dissolved solids, percent saturation, depth, turbidity); **M**=Macroinvertebrate and Habitat Quality; **N**=Nutrients (total phosphorus, ammonia, nitrate/nitrite-nitrogen); **P** = Macrophytes; **T**=Toxics in fish tissue (Cd, Pb, Hg, As, Se, % lipids, PCB, organochlorine pesticides)

Note: Fish toxics monitoring was also conducted by MA DEP OWM in 1994 at two locations on the Merrimack River: station F0082 in Lowell (segment MA84A-01) and station F0083 in Lawrence (segment MA84A-03) (Table B8).

BASELINE LAKE SURVEYS

Baseline lake surveys were conducted between July and September 1999 to coincide with maximum growth of aquatic vegetation, highest recreational use, and highest lake productivity. Lakes were sampled three times each (monthly intervals). The deep hole of Newfield Pond, Chelmsford was sampled 13 July, 10 August, and 7 September 1999. The deep holes of Flint Pond, Tyngsborough and Massapoag Pond, Dunstable/Groton/Tyngsborough were sampled 14 July, 11 August, and 9 September 1999. Total phosphorus samples were also collected from two additional sites in Massapoag Pond (station B southeast from opening into western cove and station C southern end of western cove) during these surveys.

In situ measurements using the Hydrolab® (measures dissolved oxygen, water temperature, pH, conductivity, and depth and calculates total dissolved solids and % oxygen saturation) were recorded at various depths (profile) at the deep hole station. In-lake samples were also collected for alkalinity, total phosphorus, apparent color, and chlorophyll *a* (an integrated sample). Procedures used for water sampling and sample handling are described in the *Grab Collection Techniques for DWM Water Quality Sampling Standard Operating Procedure* and the *Hydrolab® Series 3 Multiprobe Standard Operating Procedure* (MA DEP 1999b and MA DEP 1999c). The Wall Experiment Station (WES), the MA DEP's analytical laboratory, supplied all sample bottles and field preservatives, which were prepared according to the WES *Laboratory Quality Assurance Plan and Standard Operating Procedures* (MA DEP 1995). Samples were preserved in the field as necessary, transported on ice to WES, and analyzed according to the WES Standard Operating Procedure (SOP). The quality control protocol that was followed for field and equipment blank samples is described in Appendix A of this report. Both quality control samples (field blanks, trip blanks, and split samples) and raw water quality samples were transported on ice to WES on each sampling date; they were subsequently analyzed according to the WES SOP. Information about data quality objectives (accuracy, precision, detection limits, holding times, representativeness and comparability) is also presented in Appendix A. Apparent color and chlorophyll *a* were measured according to standard procedures at the MA DEP DWM office in Worcester (MA DEP 1999d and MA DEP

1999e). An aquatic macrophyte survey was conducted at each lake. The aquatic plant cover (native and non-native) and species distribution was mapped and recorded. Details on procedures used can be found in the *Baseline Lake Survey Quality Assurance Project Plan* (DEP DWM 1999a).

FISH TOXICS MONITORING

1999 FISH TOXICS

Fish toxics monitoring was conducted by DWM at three sites in the Merrimack River Basin in 1999 (Figure B1, Tables B5, B6, B7). Fish were collected using gill nets, trot lines, and boat mounted electrofishing gear at Chadwicks Pond (Haverhill/Boxford) on 21 April 1999. Fish were collected via trot lines and boat mounted electrofishing gear at Johnsons Pond on 6-7 May 1999. Lake Cochichewick in North Andover was sampled using boat mounted electrofishing gear on 17-18 May 1999. Fish were held in an onboard livewell until an appropriate sample number was reached, at which time the fish selected were placed in an ice filled cooler and brought back to the DWM laboratory for processing. Fish were sorted by type and processed at the DWM laboratory as individual samples or composite samples comprised of tissue from three or more like-sized individual fish.

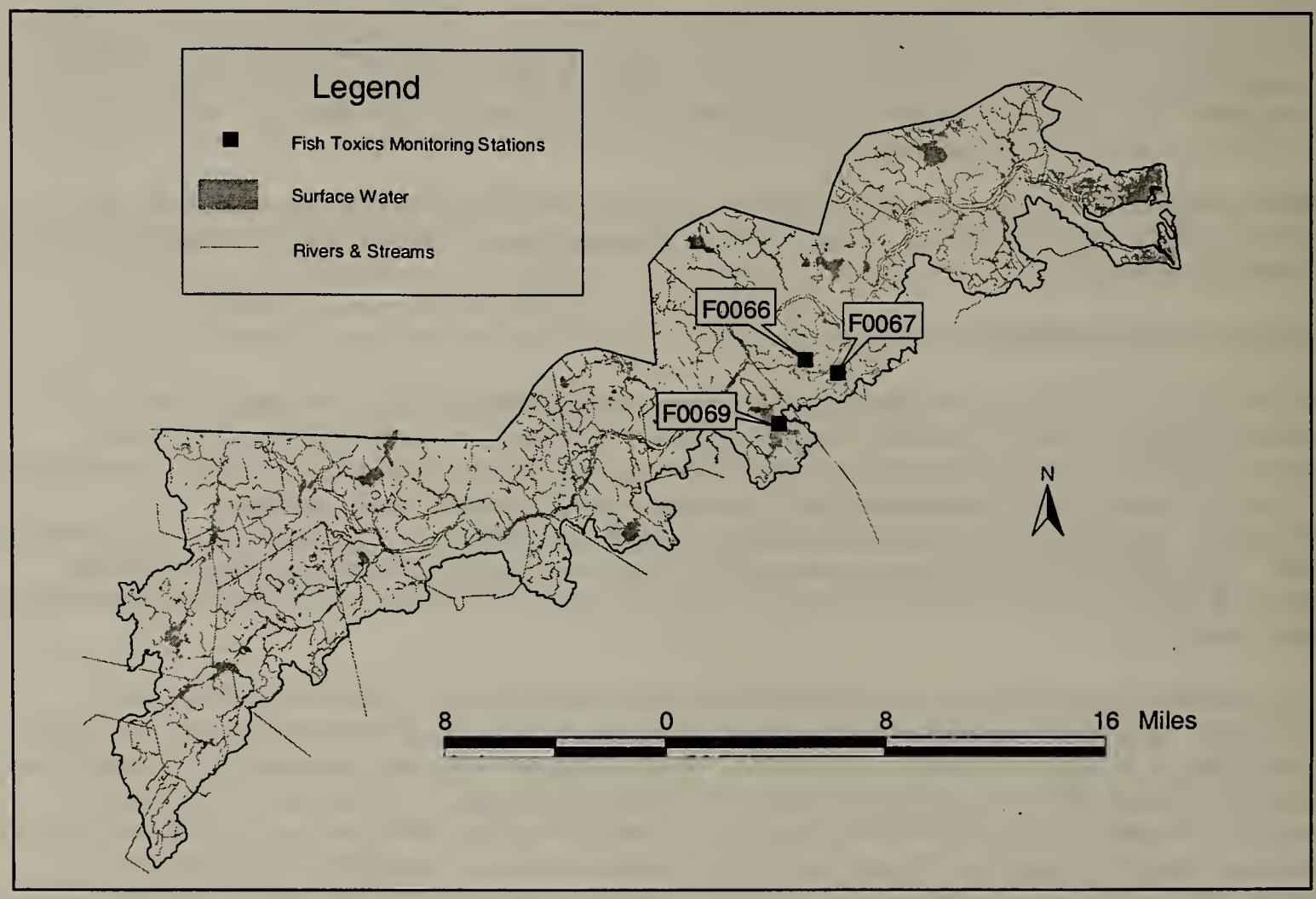


Figure B1. Locations of 1999 DEP DWM fish contaminant monitoring stations (Chadwicks Pond – F0066, Johnsons Pond – F0067, Lake Cochichewick F0069) in the Merrimack River Basin.

Protocols designed to assure accuracy and prevent cross-contamination of samples were followed for collecting, processing and shipping fish (MA DEP 1999f). Lengths and weights were measured and fish were visually inspected for tumors, lesions, or other anomalies. Scale or pectoral fin spine samples were obtained from each fish to determine age. Fish were filleted (skin off) on glass cutting boards and prepared for freezing. All equipment used in the filleting process was rinsed twice in tap water to remove slime, scales, and other fluids such as blood, then re-rinsed in deionized water before (and/or after) each

sample. Composite samples (single fillets from three like-sized individuals of the same species) targeted for % lipids, PCB and organochlorine pesticide analysis were wrapped together in aluminum foil. Composite samples targeted for metals analysis were placed in VWR 32-ounce high-density polyethylene (HDPE) cups with covers. Individual samples targeted for Hg analysis only were also placed in VWR 32-ounce high density polyethylene (HDPE) cups with covers. Samples were tagged and frozen for subsequent delivery to the Department's Wall Experiment Station (WES).

Methods used at WES for metals and PCB/organochlorine pesticide analysis is provided in Appendix A of this report and additional information is available from the WES laboratory (MA DEP 1995). According to standard practice, all laboratory analytical results were forwarded to the MDPH for review.

1994 FISH TOXICS

During September 1994 fish toxics monitoring was conducted by MA DEP OWM at two stations on the Merrimack River (Figure B2). OWM staff collected fish via gill nets, trot lines, and/or boat mounted electrofishing gear from two reaches on the Merrimack River (upstream of the Pawtucket Dam between Tyngs Island, Tyngsborough and the Lowell Heritage State Park, Lowell and between Route 93, Andover/Methuen and the dam upstream of the O'Leary Bridge, Lawrence) on 15 September 1994. Fish selected for analysis were placed in an ice filled cooler and brought back to the DWM laboratory for processing. Data for the Merrimack River in Lawrence (F0083) and the Merrimack River in Lowell (F0082) is presented in Table B8.

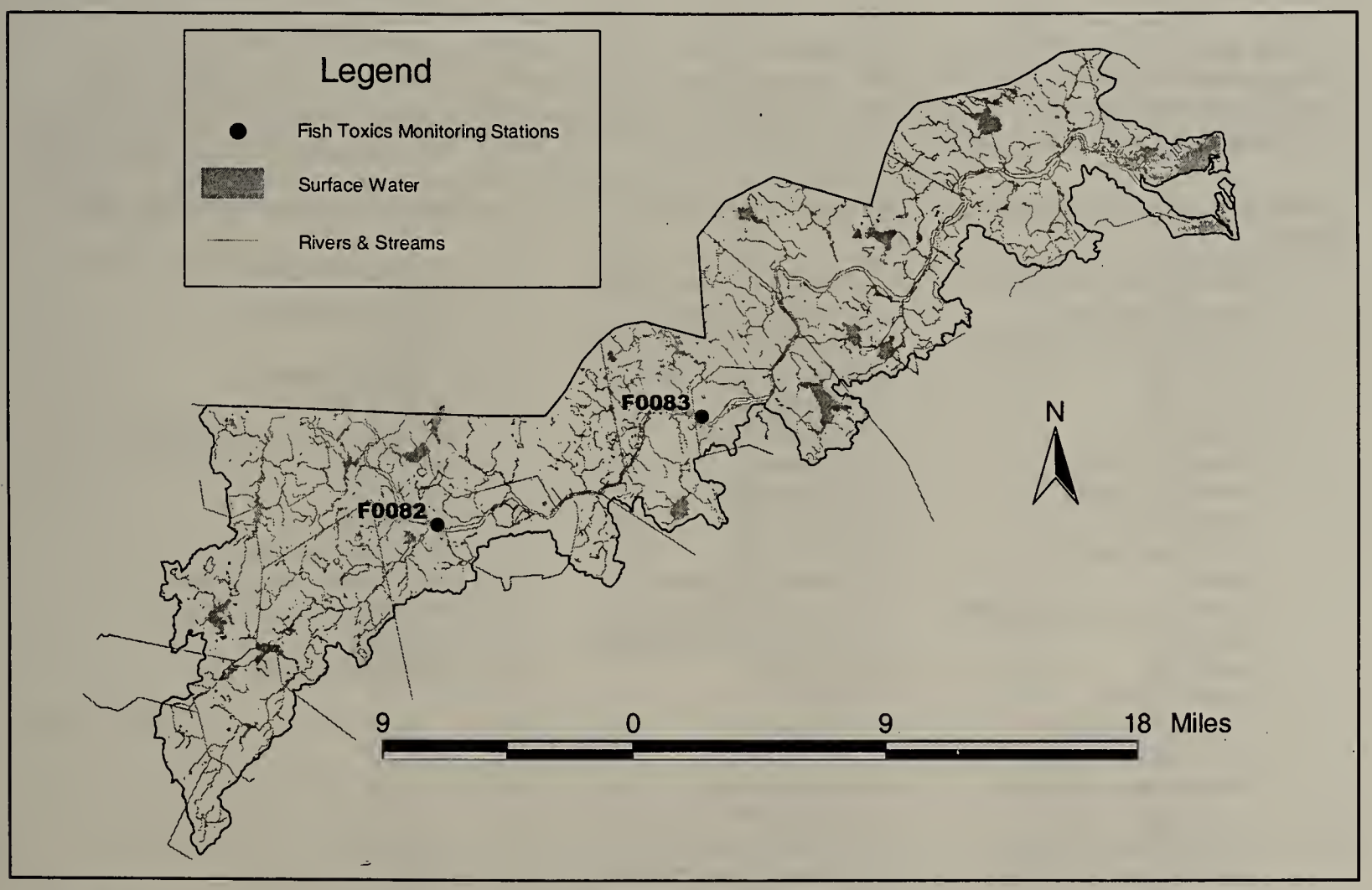


Figure B2. Locations of 1994 DEP OWM fish contaminant monitoring stations on the Merrimack River.

BENTHIC MACROINVERTEBRATE STUDIES

A technical memorandum (Appendix C) by John Fiorentino of DEP DWM entitled *Merrimack River Watershed 1999 Biological Assessment* presents details related to the collection, handling, and processing of aquatic macroinvertebrate samples (as well as the analysis results) collected from selected sites in the Merrimack River Basin during July 1999.

RESULTS

BASELINE LAKE SURVEYS

Twenty five sites were surveyed for macrophytes on Massapoag Pond, Dunstable/Groton/Tyngsborough (MA DEP 1999g). The pond was approximately 50% covered with plants. The trophic status is estimated as mesotrophic. Of the plants observed (Table B2), the dominant species appeared to be *Potomogeton robbinsii*, *Elodea* sp., and *Potamogeton crispus/Potamogeton pectinatus* with the *Potamogeton robbinsii* occurring almost twice as often as the others.

Forty sites were surveyed for macrophytes on Newfield Pond (MA DEP 1999g). The pond was approximately 75% covered with plants. The trophic status is estimated as eutrophic. Of the plants observed (Table B2), the dominant species appeared to be *Myriophyllum spicatum, Lythrum salicaria, and Najas* sp.

Twelve sites were surveyed for macrophytes on Flint Pond, Tyngsborough (MA DEP 1999g). More observation sites were unwarranted as the pond was approximately 100% covered with plants. The trophic status is estimated as eutrophic. Of the plants observed (Table B2), the dominant species appeared to be *Nymphaea* sp., *Brasenia schreberi, and Najas minor.*

Table B2. Aquatic macrophytes observed by DEP DWM in 1999 in Massapoag, Newfield and Flint ponds.

Massapoag Pond 84087	**Newfield Pond 84046**	**Flint Pond 84012**
Brasenia schreberi	*Brasenia schreberi*	*Brasenia schreberi*
Ceratophyllum demersum	*Ceratophyllum demersum*	*Chara* sp.
Chara sp.	*Cabomba caroliniana*[2]	filamentous algae
Cyperus sp.	*Elatine* sp.	Lythrum salicaria[1]
Elodea sp.	*Eleocharis* sp.	*Myriophyllum heterophyllum*[2]
Eriocaulum sp.	*Elodea* sp.	*Najas minor*[2]
filamentous algae	*Gratiola* sp.	*Nuphar* sp.
Gratiola sp.	*Iris* sp.	*Nymphaea* sp.
Lythrum salicaria[1]	*Lemna* sp.	*Pontederia cordata*
moss	*Lythrum salicaria*[1]	*Potamogeton amplifolias*
Myriophyllum heterophyllum[2]	macroscopic algae	*Potamogeton robbinsii*
Najas sp.	*Myriophyllum spicatum*[2]	*Typha latifolia*
Nuphar sp.	*Najas* sp.	*Utricularia vulgaris*
Nymphaea sp.	*Nitella*	
Pontederia cordata	*Nuphar* sp.	
Potamogeton crispus[2]	*Nymphaea* sp.	
Potamogeton epihydrus	*Peltandra* sp.	
Potamogeton natans	*Phragmites* sp. [1]	
Potamogeton pectinatus	*Pontederia cordata*	
Potamogeton robbinsii	*Potamogeton amplifolias*	
Sagittaria sp.	*Potamogeton crispus*[2]	
Typha latifolia	*Potamogeton natans*	
Utricularia sp.	*Potamogeton robbinsii*	
	Potamogeton sp. (thin leaf)	
	Typha latifolia	
	Utricularia vulgaris	
	Vallisneria americana	

[1] non-native wetland species [2] non-native aquatic species

The Hydrolab® *in-situ* data are provided in Table B3. Alkalinity, total phosphorus, apparent color, chlorophyll *a*, and Secchi depth data are provided in Table B4. These data are managed and maintained in DWM's *Water Quality Data Access Database*.

Table B3. 1999 DEP DWM Merrimack River Basin *in-situ* Hydrolab® data.

Date	OWMID	OWMID QA/QC	Time (24hr)	Depth (m)	Temp (°C)	pH (SU)	Cond@ 25°C (uS/cm)	TDS (mg/L)	DO (mg/L)	SAT (%)
Chadwicks Pond (Palis: 84006)										
Station: deep hole	**Description: Chadwicks Pond, Boxford/Haverhill.**									
04/21/99	FM-0001		11:41	** im	13.3 m	7.2 m	151 m	97.0 m	10.9m	102 m
			11:42	0.9 m	12.3 m	7.3 m	151 m	96.0 m	10.9m	100 m
			11:43	2.0 m	12.1 m	7.3 m	151 m	97.0 m	10.9m	100 m
			11:44	3.1 m	11.9 m	7.3 m	149 m	95.0 m	10.9m	99 m
			11:44	4.0 m	11.7 m	7.3 m	153 m	98.0 m	10.7m	97 m
			11:45	5.0 m	11.4 m	7.3 m	151 m	97.0 m	10.6m	96 m
			11:46	6.0 m	11.2 m	7.3 m	149 m	96.0 m	10.2m	91 m
			11:47	6.9 m	11.1 m	7.2 m	151 m	97.0 m	10.0m	90 m
			11:50	7.5 m	11.0 m	7.1 m	148 m	95.0 m	9.6m	86 m
Flint Pond (Palis: 84012)										
Station: A	**Description: deep hole, center of eastern lobe, Tyngsborough.**									
07/14/99	LB-0019		15:55	0.5	24.7	7.0	349	223	7.2	84
			16:02	1.2	24.1	6.9	342	219	6.4	74
08/11/99	LB-0173	LB-0174	09:58	0.5	22.5	6.8	386	247	5.3	60
			10:03	1.0	22.5	6.8	386	247	5.2	60
	LB-0174	LB-0173	10:10	0.5	22.5	6.8	385	246	5.3	60
			10:18	1.0	22.5	6.8	385	246	5.3	60
09/09/99	LB-0313		10:31	0.5	24.9	7.4	402	257	8.5	101
Massapoag Pond (Palis: 84087)										
Station: A	**Description: deephole, center of large eastern lobe, Dunstable/Tyngsboro.**									
07/14/99	LB-0013		12:08	0.5	25.0	7.3	196	125	7.7	91
			12:15	2.0	24.5	7.3	196	125	7.9	93
			12:22	3.5	24.0	7.3	195	125	7.4 u	85 u
			12:28	4.0	23.1	6.9	196	125	5.2	59
			12:37	6.5	12.3	6.4	178	114	0.6	6
			12:46	9.0	7.3	6.6	214	137	<0.2	<2
			12:54	10.0	6.7	6.8	238	152	<0.2	<2
			13:00	10.7	6.5	6.8	261	167	<0.2	<2
08/11/99	LB-0168		13:30	0.5	23.9	7.3	198	127	7.9	92
			13:43	2.5	23.9	7.4	195	125	7.9	92
			13:49	4.2	23.5	7.1	193	124	6.5	75
			13:56	4.7	22.3 u	6.7	200	128	3.2	37
			14:07	5.5	18.0	6.6	194	124	1.7	17
			14:14	6.5	13.1	6.5	191	122	<0.2	<2
			14:19	7.5	10.2 u	6.4	194	124	<0.2	<2
			14:25	8.5	8.3 u	6.7	216	138	<0.2	<2
			14:30	9.6	7.2	6.8	254	163	<0.2	<2
09/09/99	LB-0318		15:06	0.5	25.6	8.0	199	127	9.0	108
			15:11	2.2	25.2	7.9	198	127	8.7	104
			15:17	4.0	22.7	7.2	199	127	7.3	83
			15:21	4.5	21.9 u	7.0	198	127	4.6 u	52 u
			15:26	6.2	16.1	6.7	199	127	2.3 u	23 u
			15:32	8.0	9.5	6.8	221	141	<0.2	<2
			15:37	8.4	8.5 u	6.9	239	153	<0.2	<2
			15:42	9.3	7.4	7.0	285	182	<0.2	<2
			15:54	10.5	7.0	7.2	341	219	<0.2	<2

** missing/censored data, QUALIFIERS: **u** = unstable readings; **I** = inaccurate readings; **m** = method not followed/instrument failure

Table B3. Continued. 1999 DEP DWM Merrimack River Basin *in-situ* Hydrolab® data.

Date	OWMID	OWMID QA/QC	Time (24hr)	Depth (m)	Temp (°C)	pH (SU)	Cond@ 25°C (uS/cm)	TDS (mg/L)	DO (mg/L)	SAT (%)
Johnsons Pond (Palis: 84027)										
Station: hole	**Description: Johnsons Pond, Boxford/Groveland.**									
05/06/99	FM-0003		14:20	1.4	14.6	7.4	138	88.2	10.2	99
			14:26	3.2	14.4	7.4	138	88.4	10.0	96
			14:35	5.9	12.0	6.7	137	87.9	4.6	42
			14:43	7.5	11.4	6.6	140	89.5	1.4	12
Lake Cochichewick (Palis: 84008)										
Station: hole	**Description: Lake Cochichewick, North Andover.**									
05/17/99	FM-0006		14:38	0.5	18.0	7.7	155	99.0	10.5	108
			14:45	3.6	15.4	7.4	158	101	10.6	103
			14:48	6.9	13.0	6.7	159	102	7.5	69
			14:49	7.8	12.1	6.6	161	103	6.0	54
			14:52	8.1	12.0	6.4	154	99.0	5.3	48
Newfield Pond (Palis: 84046)										
Station: A	**Description: deep hole in southeastern quadrant near outlet, Chelmsford.**									
07/13/99	LB-0006		10:21	0.5	24.6	7.3	412	263	7.7	90
			10:25	1.5	24.6	7.3	412	263	7.7	90
			10:28	2.5	24.6	7.4	412	263	7.7	90
			10:32	3.5	24.1 **u**	7.0	411	263	4.7	55
			10:39	4.5	18.2 **u**	6.6	392	251	0.3	3
			10:44	5.5	14.1	6.7	415	266	<0.2	<2
			10:52	6.5	12.2 **u**	7.0	448	287	<0.2	<2
			10:59	7.0	11.7	7.2	480	307	<0.2	<2
08/10/99	LB-0156		09:45	0.4	24.2	7.4	418	268	7.8	92
			09:55	1.5	24.2	7.4	419	268	7.9	92
			10:01	2.5	24.1	7.4	418	267	7.9	93
			10:06	3.5	24.1	7.4	418	267	7.9	93
			10:11	4.5	20.9	6.7	406	260	<0.2	<2
			10:16	5.5	14.5	7.0	451	288	<0.2	<2
			10:21	6.5	12.4	7.2	515	330	<0.2	<2
			10:26	7.1	11.9	7.3	552	353	<0.2	<2
09/07/99	LB-0301		10:52	0.5	25.2	9.1	427	273	10.3	123
			11:02	1.5	24.6	9.0	427	273	10.9	128
			11:10	2.5	23.1	8.9	420	269	10.1	116
			11:18	3.5	22.4	6.9	421	269	5.1 **u**	58 **u**
			11:24	4.5	20.7	6.6	425	272	<0.2	<2
			11:30	5.5	15.6 **u**	7.0	469	300	<0.2	<2
			11:37	6.5	13.2	7.2	537	344	<0.2	<2

** missing/censored data, QUALIFIERS: **u** = unstable readings; **i** = inaccurate readings; **m** = method not followed/instrument failure

Table B4. 1999 DEP DWM Merrimack River Basin inlake Secchi depth, alkalinity, color, total phosphorus and chlorophyll *a* data.

Date	Time (24hr)	Secchi Depth (m)	Station Depth (m)	OWMID	OWMID QA/QC	Sample Depth (m)	Alkalinity (mg/L)	Color (PCU)	Total Phosphorus (mg/L)	Chlorophyll *a* (mg/L)
Flint Pond (Palis: 84012)										
Station: A		Description: deep hole, center of eastem lobe, Tyngsborough.								
07/14/99	15:38	>1.5	1.5							
				LB-0021		** - **	--	--	--	12**b**
				LB-0020	LB-0022	0.5	28	50	0.025	--
				LB-0022	LB-0020	0.5	25	65	0.025	--
				LB-0024		1.3	26	50	0.030	--
08/11/99	9:50	>1.5	1.5							
				LB-0172		0 - 1.0	--	--	--	14
				LB-0169	LB-0170	0.5	33	28**d**	0.021	--
				LB-0170	LB-0169	0.5	35	35**d**	0.021	--
				LB-0175		1.0	33	--	0.030	--
09/09/99	11:00	>1.4**e**	1.2**e**							
				LB-0317		** - **	--	--	--	**m
				LB-0315	LB-0314	**	37	--	0.016	--
				LB-0314	LB-0315	0.5	36	--	0.017	--
Massapoag Pond (Palis: 84087)										
Station: A		Description: deephole, center of large eastern lobe, Dunstable/Tyngsboro.								
07/14/99	11:25	4.6	12.5							
				LB-0015		** - **	--	--	--	57**b**
				LB-0014		0.5	28	<15	0.013	--
				LB-0016		10.5	42	260	0.82	--
08/11/99	13:25	3.1	9.9							
				LB-0165		0 - 8.0	--	--	--	20
				LB-0163		0.5	30	17**d**	0.016	--
				LB-0164		9.5	46	120**d**	0.41	--
09/09/99	14:25	3.2	11.6							
				LB-0321		** - **	--	--	--	**m
				LB-0319		0.5	30	--	0.011	--
				LB-0320		10.5	57	--	0.83	--
Station: B		Description: southeast from opening into western cove, Tyngsboro.								
07/14/99	**	--	--							
				LB-0017		0.5	--	--	0.014	--
08/11/99	**	--	--							
				LB-0166		0.5	--	--	0.018	--
09/09/99	**	--	--							
				LB-0322		**	--	--	0.012	--
Station: C		Description: southem end of western cove, Groton.								
07/14/99	**	--	--							
				LB-0018		0.5	--	--	0.022	--
08/11/99	**	--	--							
				LB-0167		0.5	--	--	0.016	--
09/09/99	**	--	--							
				LB-0323		**	--	--	0.014	--

** = missing/censored data - including unanalyzed samples; lost data; or poor quality/discarded data

-- = no data (no sample collected)

QUALIFIERS: **b** = blank contamination; **d** = precision of field duplicates did not meet project data quality objectives, **e** = not theoretically possible, **m** = field and/or lab SOPs not followed or lost/unanalyzed samples

Table B4. Continued. 1999 DEP DWM Merrimack River Basin inlake Secchi depth, alkalinity, color, total phosphorus and chlorophyll *a* data.

Date	Time (24hr)	Secchi Depth (m)	Station Depth (m)	OWMID	OWMID QA/QC	Sample Depth (m)	Alkalinity (mg/L)	Color (PCU)	Total Phosphorus (mg/L)	Chlorophyll *a* (mg/L)
Newfield Pond (Palis: 84046)										
Station: A		Description: deep hole in southeastern quadrant near outlet, Chelmsford.								
07/13/99	9:58	2.4	7.6							
				LB-0004		** - **	--	--	--	11b
				LB-0002	LB-0001	**	26	17m	0.022	--
				LB-0001	LB-0002	0.5	26	<15m	0.022	--
				LB-0005		7.0	53	300m	**m	--
08/10/99	9:45	1.9	7.6							
				LB-0154		0 - 5.7	--	--	--	1
				LB-0151	LB-0152	0.5	26	23	0.024	--
				LB-0152	LB-0151	0.5	27	23	0.024	--
				LB-0155		6.3	53	120	**m	--
09/07/99	10:20	1.9	8.2							
				LB-0305		** - **	--	--	--	**m
				LB-0303	LB-0302	**	29	--	0.018	--
				LB-0302	LB-0303	0.5	27	--	0.020	--
				LB-0306		6.5	70	--	0.062	--

** = missing/censored data - including unanalyzed samples; lost data; or poor quality/discarded data

-- = no data (no sample collected)

QUALIFIERS: **b** = blank contamination; **d** = precision of field duplicates did not meet project data quality objectives, **e** = not theoretically possible, **m** = field and/or lab SOPs not followed or lost/unanalyzed samples

FISH TOXICS MONITORING

1999 FISH TOXICS

The results of DWM's 1999 fish toxics monitoring surveys are briefly described below for each lake sampled (MA DEP 1999h).

Chadwicks Pond, Haverhill/Boxford F0066 (Table B5)
Samples of largemouth bass, yellow perch, and yellow bullhead were collected from Chadwicks Pond, Haverhill/Boxford. The lipids content ranged between 0.06 and 0.20%. Cadmium, PCB, pesticides, arsenic and lead were not detected in the edible fillets of any sample analyzed for these analytes from Chadwicks Pond. Selenium levels ranged from 0.077 to 0.114 mg/kg wet weight. Mercury in the fish tissue from Chadwicks Pond ranged from 0.43 to 1.7 mg/kg wet weight. The mercury data triggered a site-specific advisory against the consumption of fish from Chadwicks Pond, Haverhill/Boxford (MDPH 1999).

Lake Cochichewick, North Andover F0069 (Table B6)
Samples of largemouth bass and yellow perch were collected from Lake Cochichewick in North Andover. The lipids content ranged between 0.06 and 0.11%. Cadmium, lead, PCB and pesticides were not detected in the edible fillets of any sample analyzed for these analytes from Lake Cochichewick. Selenium levels ranged from 0.145 to 0.193 mg/kg wet weight. Mercury in the fish tissue from Lake Cochichewick ranged from 0.14 to 1.0 mg/kg wet weight. The mercury data triggered a site-specific advisory against the consumption of fish from Lake Cochichewick, North Andover (MDPH 1999).

Johnsons Pond, Groveland/Boxford F0067 (Table B7)
Samples of largemouth bass, yellow perch, and yellow and brown bullhead were collected from Johnsons Pond, Groveland/Boxford. The lipids content of the fish analyzed ranged between 0.06 and 0.74%. Cadmium, lead, arsenic, PCB and pesticides were not detected in the edible fillets of any sample analyzed for these analytes from Johnsons Pond. Selenium was detected in all samples analyzed ranging from 0.103 to 0.138 mg/kg wet weight. Mercury in the fish tissue from Johnsons Pond ranged

from 0.22 to 0.79 mg/kg wet weight. The data triggered a site-specific advisory against the consumption of fish from Johnsons Pond, Groveland/Boxford (MDPH 1999).

1994 FISH TOXICS

The goal of the 1994 fish toxics monitoring was to screen resident fishes for PCB, organochlorine pesticides, percent lipids, and selected metals (As, Cd, Pb, Hg and Se). Where possible, fish selected for analysis represented species and sizes desired by the angling public for consumption, as well as different feeding guilds (i.e., predator, invertivore, omnivore). Survey results are presented in Table B8 (MA DEP 1994).

Merrimack River, Lowell (F0082) (Table B8)
Samples of white sucker and yellow bullhead were collected from the Merrimack River (upstream of the Pawtucket Dam between Tyngs Island, Tyngsborough and the Lowell Heritage State Park, Lowell), using gill nets and/or trot lines. The lipids content ranged between 0.39 and 1.0%. Cadmium, lead, PCB and pesticides were not detected in the edible fillets of any sample analyzed for these analytes from this reach of the Merrimack River. Selenium levels ranged from non-detect, <0.04 to 0.099 mg/kg wet weight. Mercury in the fish tissue ranged from 0.353 to 0.500 mg/kg wet weight.

Merrimack River, Lawrence (F0083) (Table B8)
Samples of largemouth and smallmouth bass, common carp, brown bullhead, white catfish, and white and yellow perch were also collected from the Merrimack River (between Route 93, Andover/Methuen and the dam upstream of the O'Leary Bridge, Lawrence), using boat mounted electroshocking gear, gill nets, and/or trot lines. The lipids content ranged between 0.12 and 4.5%. Cadmium, lead, and pesticides were not detected in the edible fillets of any sample analyzed for these analytes from this reach of the Merrimack River. Selenium levels ranged from non-detect, <0.04 to 0.132 mg/kg wet weight. Mercury in the fish tissue ranged from 0.238 to 0.572 mg/kg wet weight.

The mercury data triggered an advisory against the consumption of fish from the Merrimack River in all towns between Tyngsborough and Methuen (MDPH 1995).

BENTHIC MACROINVERTEBRATE STUDIES

A technical memorandum (Appendix C) by John Fiorentino of DEP DWM entitled *Merrimack River Watershed 1999 Biological Assessment* presents the aquatic macroinvertebrate analysis results (as well as details related to sampling and processing) for samples collected from selected sites in the Merrimack River Basin during July 1999.

Table B5. 1999 DEP DWM fish toxics monitoring data for Chadwicks Pond, Haverhill/Boxford (F0066). Results, reported in wet weight, are from fish fillets with skin off and are of individual fillets or composite samples as noted.

Sample ID	Collection Date	Species[1] Code	Length (cm)	Weight (g)	Individual Sample ID (lab sample #)	Hg	Composite Sample ID (lab sample #)	Cd (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	As (mg/kg)	Se (mg/kg)	Lipids (%)	PCB (µg/g)	Pesticides (µg/g)
HAVCP-1	4/21/99	LMB	39.8	963.9	99001 (L990113-1)	1.7	99066 (L990113-20)	<0.02	1.4	<0.2	<0.04	0.077	0.07	ND	ND
HAVCP-2	4/21/99	LMB	39.5	916.2	99002 (L990113-2)	0.59									
HAVCP-3	4/21/99	LMB	30.9	572.3	99003 (L990113-3)	1.1									
HAVCP-4	4/21/99	LMB	36.4	728.6	99004 (L990113-4)	1.0									
HAVCP-5	4/21/99	LMB	36.5	723.1	99005 (L990113-5)	1.3									
HAVCP-6	4/21/99	LMB	37.0	785.1	99006 (L990113-6)	1.4									
HAVCP-7	4/21/99	LMB	38.1	698.9	99007 (L990113-7)	1.1									
HAVCP-8	4/21/99	LMB	35.7	630.1	99008 (L990113-8)	1.2									
HAVCP-9	4/21/99	LMB	31.2	410.2	99009 (L990113-9)	0.95									
HAVCP-10	4/21/99	YP	24.6	145.4	99010 (L990113-10)	0.57	99067 (L990113-21)	<0.02	0.82	<0.2	<0.04	0.114	0.06	ND	ND
HAVCP-11	4/21/99	YP	25.1	184.4	99011 (L990113-11)	0.67									
HAVCP-12	4/21/99	YP	24.0	174.3	99012 (L990113-12)	1.1									
HAVCP-13	4/21/99	YP	25.5	188.8	99013 (L990113-13)	0.59									
HAVCP-14	4/21/99	YP	22.6	140.5	99014 (L990113-14)	0.48									
HAVCP-15	4/21/99	YP	22.4	136.6	99015 (L990113-15)	0.77									
HAVCP-16	4/21/99	YP	22.9	128.4	99016 (L990113-16)	0.83									
HAVCP-17	4/21/99	YP	23.6	130.3	99017 (L990113-17)	0.43									
HAVCP-18	4/21/99	YP	21.2	105.1	99018 (L990113-18)	0.54									
HAVCP-19	4/21/99	YB	23.4	211.3	--	--	99068 (L990113-22)	<0.02	--	<0.20	<0.04	0.086	0.20	ND	ND
HAVCP-20	4/21/99	YB	25.5	210.5			99019 (L990113-19)		1.1						
HAVCP-21	4/21/99	YB	25.1	238.9			(L990113-22)		1.3						

[1]Species largemouth bass (LMB) *Micropterus salmoides*
yellow bullhead (YB) *Ameiurus natalis*
yellow perch (YP) *Perca flavescens*

ND = not detected or the analytical result is at or below the established detection limit (MDL). See Appendix A for MDL.
-- = no data
NOTE: mg/kg = µg/g = ppm = mg/l

Table B6. 1999 DEP DWM fish toxics monitoring data for Lake Cochichewick, North Andover (F0069). Results, reported in wet weight, are from fish fillets with skin off and are of individual fillets or composite samples as noted.

Sample ID	Collection Date	Species[1] Code	Length (cm)	Weight (g)	Individual Sample ID (lab sample #)	Hg	Composite Sample ID (lab sample #)	Cd (mg/kg)	Pb (mg/kg)	As (mg/kg)	Se (mg/kg)	Lipids (%)	PCB (µg/g)	Pesticides (µg/g)
NANLC-1	5/17-18/99	LMB	32.4	435.5	99118 (L990166-1)	0.47	99136 (L990166-19)	<0.02	<0.20	0.097	0.145	--	--	--
NANLC-2	5/17-18/99	LMB	31.3	415.7	99119 (L990166-2)	0.59								
NANLC-3	5/17-18/99	LMB	33.1	485.1	99120 (L990166-3)	0.67								
NANLC-4	5/17-18/99	LMB	34.2	525.0	99121 (L990166-4)	0.43	99137 (L990166-20)	--	--	--	--	0.11	ND	ND
NANLC-5	5/17-18/99	LMB	33.5	566.8	99122 (L990166-5)	0.40								
NANLC-6	5/17-18/99	LMB	36.1	741.1	99123 (L990166-6)	0.43								
NANLC-7	5/17-18/99	LMB	35.1	644.5	99124 (L990166-7)	0.63	--	--	--	--	--	--	--	--
NANLC-8	5/17-18/99	LMB	38.0	800.9	99125 (L990166-8)	1.0								
NANLC-9	5/17-18/99	LMB	37.0	811.3	99126 (L990166-9)	0.59								
NANLC-10	5/17-18/99	YP	21.3	121.1	99127 (L990166-10)	0.41	99138 (L990166-21)	<0.02	<0.20	0.147	0.193	--	--	--
NANLC-11	5/17-18/99	YP	22.9	144.9	99128 (L990166-11)	0.34								
NANLC-12	5/17-18/99	YP	24.5	188.7	99129 (L990166-12)	0.39								
NANLC-13	5/17-18/99	YP	24.5	179.8	99130 (L990166-13)	0.45	99139 (L990166-22)	--	--	--	--	0.06	ND	ND
NANLC-14	5/17-18/99	YP	23.2	155.9	99131 (L990166-14)	0.14								
NANLC-15	5/17-18/99	YP	23.2	145.6	99132 (L990166-15)	0.31								
NANLC-16	5/17-18/99	YP	23.4	178.1	99133 (L990166-16)	0.25	--	--	--	--	--	--	--	--
NANLC-17	5/17-18/99	YP	25.1	231.0	99134 (L990166-17)	0.28								
NANLC-18	5/17-18/99	YP	26.8	224.7	99135 (L990166-18)	0.32								

[1]Species largemouth bass (LMB) *Micropterus salmoides*
yellow perch (YP) *Perca flavescens*

NOTE: mg/kg = µg/g = ppm = mg/l

ND = not detected or the analytical result is at or below the established detection limit (MDL). See Appendix A for MDL.

-- = no data

Table B7. 1999 DEP DWM fish toxics monitoring data for Johnsons Pond, Groveland/Boxford (F0067). Results (mg/kg wet wt.) are from fish fillets with skin off and are of individual fillets or composite samples as noted.

Sample ID	Collection Date	Species[1] Code	Length (cm)	Weight (g)	Individual Sample ID (lab sample #)	Hg	Composite Sample ID (lab sample #)	Cd (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	As (mg/kg)	Se (mg/kg)	Lipids (%)	PCB (µg/g)	Pesticides (µg/g)
GRVJP-1	5/6-7/99	LMB	31.5	379.5	99042 (L990140-1)	0.39	99045 (L990142-1)	<0.02	--	<0.20	<0.04	0.122	--	--	--
GRVJP-2	5/6-7/99	LMB	30.0	370.2	99043 (L990140-2)	0.40									
GRVJP-3	5/6-7/99	LMB	31.5	443.6	99044 (L990140-3)	0.48									
GRVJP-4	5/6-7/99	LMB	34.5	547.6	99046 (L990140-4)	0.70	99049 (L990142-2)	--	--	--	--	--	0.07	ND	ND
GRVJP-5	5/6-7/99	LMB	36.0	652.3	99047 (L990140-5)	0.66									
GRVJP-6	5/6-7/99	LMB	38.0	699.9	99048 (L990140-6)	0.74									
GRVJP-7	5/6-7/99	LMB	37.3	763.5	99050 (L990140-7)	0.60	--	--	--	--	--	--	--	--	--
GRVJP-8	5/6-7/99	LMB	38.4	847.5	99051 (L990140-8)	0.70									
GRVJP-9	5/6-7/99	LMB	37.5	813.1	99052 (L990140-9)	0.79									
GRVJP-10	5/6-7/99	YP	23.4	151.1	99053 (L990140-10)	0.34	99056 (L990142-3)	<0.02		<0.20	<0.04	0.138	--	--	--
GRVJP-11	5/6-7/99	YP	23.3	146.9	99054 (L990140-11)	0.31									
GRVJP-12	5/6-7/99	YP	23.0	132.9	99055 (L990140-12)	0.35									
GRVJP-13	5/6-7/99	YP	21.0	115.6	99057 (L990140-13)	0.39	99060 (L990142-4)	--	--	--	--	--	0.06	ND	ND
GRVJP-14	5/6-7/99	YP	22.4	116.9	99058 (L990140-14)	0.22									
GRVJP-15	5/6-7/99	YP	21.3	113.3	99059 (L990140-15)	0.34									
GRVJP-16	5/6-7/99	YP	21.6	116.4	99061 (L990140-16)	0.23	--	--	--	--	--	--	--	--	--
GRVJP-17	5/6-7/99	YP	21.1	110.9	99062 (L990140-17)	0.28									
GRVJP-18	5/6-7/99	YP	22.1	116.9	99063 (L990140-18)	0.25									
GRVJP-19	5/6-7/99	YB	30.9	408.6	--	--	99065 (L990142-5)	<0.02	--	<0.20	<0.04	0.103	0.74	ND	0.011[2]
GRVJP-20	5/6-7/99	YB	30.0	378.3											
GRVJP-21	5/6-7/99	BB	33.8	506.5			99064 (L990140-19)		0.41						

[1]Species brown bullhead (BB) *Ameiurus nebulosus*
largemouth bass (LMB) *Micropterus salmoides*
yellow bullhead (YB) *Ameiurus natalis*
yellow perch (YP) *Perca flavescens*

[2]DDE

-- = no data

NOTE: mg/kg = µg/g = ppm = mg/l

ND = not detected or the analytical result is at or below the established detection limit (MDL). See Appendix A for MDL.

Table B8. 1994 DEP OWM fish toxics monitoring data for the Merrimack River in Lawrence and Lowell. Results, reported in wet weight, are from composite samples of fish fillets with skin off.

Sample ID	Collection Date	Species[1] Code	Length (cm)	Weight (g)	Sample ID (laboratory sample #)	Cd (mg/kg)	Hg (mg/kg)	Pb (mg/kg)	As (mg/kg)	Se (mg/kg)	Lipids (%)	PCB (µg/g)	Pesticides (µg/g)
Merrimack River, Lawrence F0083													
MRF94-1	9/15/94	LMB	40.8	1600	94028 (94-4161)	<0.20	0.572	<1.0	<0.04	<0.04	NR	NR	NR
MRF94-2	9/15/94	LMB	33.8	600									
MRF94-3	9/15/94	SMB	34.7	590									
MRF94-4	9/15/94	SMB	35.7	570									
MRF94-5	9/15/94	SMB	33.5	500									
MRF94-6	9/15/94	C	56.7	2500	94029 (94-4162)	<0.20	0.472	<1.0	0.041	<0.04	4.5	0.92[2]	ND
MRF94-7	9/15/94	C	49.2	1700									
MRF94-8	9/15/94	C	54.4	2380									
MRF94-9	9/15/94	C	54.4	2160									
MRF94-10	9/15/94	C	54.0	1950									
MRF94-11	9/15/94	BB	28.0	300	94030 (94-4163)	<0.20	0.238	<1.0	<0.04	<0.04	0.99	ND	ND
MRF94-12	9/15/94	BB	28.5	300									
MRF94-13	9/15/94	WC	31.9	400									
MRF94-14	9/15/94	WP	29.0	400	94031 (94-4164, duplicate)	<0.20	0.324	<1.0	<0.04	0.132	1.1	ND	ND
MRF94-15	9/15/94	WP	29.6	380									
MRF94-16	9/15/94	WP	27.1	320									
MRF94-17	9/15/94	WP	21.1	160							1.1	ND	ND
MRF94-18	9/15/94	YP	21.7	170	94032 (94-4165)	<0.20	0.358	<1.0	<0.04	<0.04	0.12	ND	ND
MRF94-19	9/15/94	YP	24.1	200									
MRF94-20	9/15/94	YP	24.1	200									
Merrimack River, Lowell F0082													
MRF94-21	9/15/94	WS	42.6	840	94026 (94-4159)	<0.20	0.500	<1.0	0.102	0.099	1.0	ND	ND
MRF94-22	9/15/94	WS	45.3	1050									
MRF94-23	9/15/94	WS	41.0	950									
MRF94-24	9/15/94	WS	40.5	840									
MRF94-25	9/15/94	WS	40.1	800									
MRF94-26	9/15/94	YB	25.1	260	94027 (94-4160)	<0.20	0.353	<1.0	<0.04	<0.04	0.39	ND	ND
MRF94-27	9/15/94	YB	24.1	210									
MRF94-28	9/15/94	YB	21.5	160									

[1]Species brown bullhead (BB) *Ameiurus nebulosus*; common carp (C) *Cyprinus carpio*; largemouth bass (LMB) *Micropterus salmoides*; smallmouth bass (SMB) *Micropterus dolomieu*; white catfish (WC) *Ameiurus catus*; white perch (WP) *Morone americana*; white sucker (WS) *Castomus commersoni*; yellow bullhead (YB) *Ameiurus natalis*; yellow perch (YP) *Perca flavescens*

[2] PCB A1254

ND = not detected or the analytical result is at or below the established detection limit (MDL). See Appendix A for MDL.

NR = not reported

NOTE: mg/kg = µg/g = ppm = mg/l

REFERENCES

MA DEP. 1994. Open File. *1994 Fish Toxics Monitoring Data in the Merrimack River Basin.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

MA DEP. 1995 January Draft. *Laboratory Quality Assurance Plan and Standard Operating Procedures.* Massachusetts Department of Environmental Protection, Division of Environmental Analysis. Wall Experiment Station, Lawrence, MA.

MA DEP. 1999a. *Baseline Lake Survey Quality Assurance Project Plan.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999b. CN 1.0 *Grab Collection Techniques for DWM Water Quality Sampling, Standard Operating Procedure.* October 25, 1999. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999c. CN 4.0 *Hydrolab® Series 3 Multiprobe, Standard Operating Procedure.* September 23, 1999. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999d. CN 2.0 *Apparent Color Standard Operating Procedures.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999e. CN 3.0 *Chlorophyll a Standard Operating Procedures.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999f. CN 13.0. *Fish Contaminant Monitoring Program, Quality Assurance Project Plan, 1999.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999g. Open File. *1999 Synoptic Lake Surveys Coding Sheets.* Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA.

MA DEP. 1999h. Open File. *1999 Fish Toxics Monitoring Data in the Merrimack River Basin.* Massachusetts Department of Environmental Protection, Division of Watershed Management, Worcester, MA.

MDPH. 1995. *ADDENDUM Massachusetts Department of Public Health Consumption Advisory List for Freshwater Bodies.* Massachusetts Department of Public Health. Boston, MA.

MDPH. 1999. *Freshwater Fish Consumption Advisory List.* Massachusetts Department of Public Health. Boston, MA.

Mattson, M. D. and R. A. Isaac. 1999. Calibration of Phosphorous Export Coefficients for Total Maximum Daily Loads of Massachusetts Lakes. *Journal of Lakes and Reservoir Management* 15(3):209-219.

Technical Memorandum (TM-84-4)

Title: MERRIMACK RIVER WATERSHED 1999 BIOLOGICAL ASSESSMENT

The net-spinning caddisfly *Hydropsyche betteni* gr., a common macroinvertebrate of the Merrimack River watershed.
Photo by Robert Nuzzo, MA DEP

Prepared by: John Fiorentino, MA DEP/ Division of Watershed Management, Worcester, MA

Date: 16 May 2001

CONTENTS

Introduction	3
Methods	6
Macroinvertebrate Sampling – RBPIII	6
Habitat Assessments	6
Maroinvertebrate Sample Processing and Analysis	6
Results and Discussion	8
FB00—Fish Brook	8
CB01—Cobbler Brook	9
BB01—Beaver Brook	11
SB02—Stony Brook	12
SR01—Spicket River	14
Summary and Recommendations	17
Literature Cited	19
Appendix—Macroinvertebrate taxa lists, RBPIII analyses, and Habitat evaluations	21

INTRODUCTION

Biological monitoring is a useful means of detecting anthropogenic impacts to the aquatic community. Resident biota (e.g., benthic macroinvertebrates, fish, periphyton) in a water body are natural monitors of environmental quality and can reveal the effects of episodic and cumulative pollution and habitat alteration (Barbour et al. 1999, Barbour et al. 1995). Biological surveys and assessments are the primary approaches to biomonitoring.

As part of the Massachusetts Department of Environmental Protection/ Division of Watershed Management's (MA DEP/DWM) 1999 Merrimack River watershed assessments, aquatic benthic macroinvertebrate biomonitoring was conducted to evaluate the biological health of various portions of the watershed. In accordance with the *Quality Assurance Project Plan for 1999 Benthic Macroinvertebrate Biomonitoring* (Fiorentino 1999), a total of five biomonitoring stations were sampled in selected tributaries to investigate the effects of various nonpoint and point source stressors—both historical and current—on the aquatic communities of the watershed. Additional sampling originally proposed for Salmon, Lawrence, and Bare Meadow/Hawkes brooks was not conducted due to habitat and/or flow constraints that made application of DWM's benthic macroinvertebrate sampling methodology in these streams unsuitable. Some stations sampled during the 1999 biomonitoring survey were previously "unassessed" by DEP, while historical DEP biomonitoring stations—most recently assessed in 1990 or 1994—were reevaluated to determine if water quality and habitat conditions have improved or worsened over time. Sampling locations, along with station identification numbers and sampling dates, are noted in Table 1. Sampling locations are also shown in Figure 1.

To provide information necessary for making basin-wide aquatic life use assessments required by Section 305(b) of the Federal Clean Water Act (CWA), all Merrimack River watershed stations were compared to a regional reference station most representative of the "best attainable" conditions in the watershed. Use of a regional reference station is particularly useful in assessing nonpoint source (NPS) pollution impacts (e.g., physical habitat degradation) at upstream control sites as well as downstream sites suspected as chemically-impacted from known point source stressors (Hughes 1989). Fish Brook (in the Merrimack River watershed) in Andover, originally recommended as a reference station by the EOEA Merrimack River Watershed Team, was determined by DWM to be inappropriate as a reference condition due to the extremely low base-flow observed during reconnaissance activities (i.e., site visits) in the watershed. As a result, the regional reference station was established at Fish Brook in Middleton—located in the nearby Ipswich River watershed. The wadeable, relatively low-gradient tributaries of the Ipswich River watershed share many similar characteristics with those of the Merrimack River watershed with respect to hydrology, channel geomorphology, and instream habitat quality. The Fish Brook station was situated upstream from all known point sources of water pollution, and was also assumed (based on topographic map examinations and field reconnaissance) to be relatively unimpacted by nonpoint sources.

During "year 1" of the 5-year basin cycle, problem areas within the Merrimack River watershed were better defined through such processes as coordination with appropriate groups (EOEA Merrimack River Watershed Team, Merrimack River Watershed Council, DEP/DWM), assessing existing data, conducting site visits, and reviewing NPDES and water withdrawal permits. Following these activities, the 1999 biomonitoring plan was more closely focused and the study objectives better defined. Table 2 includes a summary of the perceived problems/issues—both historical and current—addressed during the 1999 Merrimack River watershed biomonitoring survey.

The main objectives of biomonitoring in the Merrimack River watershed were: (a) to determine the biological health of streams within the watershed by conducting assessments based on aquatic macroinvertebrate communities; and (b) to identify problem stream segments so that efforts can be focussed on developing NPDES permits, Water Management Act permits, stormwater management measures, and control of other nonpoint source pollution. Specific tasks were:

1. Conduct benthic macroinvertebrate sampling and habitat assessments at selected locations throughout the Merrimack River watershed.

2. Based upon the macroinvertebrate data, identify river segments within the watershed with potential point/nonpoint source pollution problems; and

3. Using the benthic macroinvertebrate data and supporting water chemistry and field data:

- Assess the types of water quality and/or water quantity problems that are present, and
- if possible, make recommendations for remedial actions.
- Provide macroinvertebrate data to DWM's Environmental Monitoring and Assessment Program to be used in making aquatic life use assessments required by Section 305(b) of the Federal Clean Water Act (CWA).

Table 1. List of macroinvertebrate biomonitoring stations sampled during the 1999 Merrimack River watershed survey, including station identification number, drainage area, station description, and sampling date.

Station	Drainage Area (mi^2)	Merrimack River Watershed Station Description	Sampling Date
CB01	1.50	Cobbler Brook, upstream from Mill Street, Merrimack, MA	20 July 1999
SB02	43.24	Stony Brook, downstream from Brookside Road, Westford, MA	20 July 1999
SR01	78.00	Spicket River, downstream from General Street, near mouth, Lawrence, MA	22 July 1999
BB01	114.00	Beaver Brook, downstream from Pleasant Street, Dracut, MA	22 July 1999
FB00*	12.16	Fish Brook, upstream from Middletown Road, Boxford, MA	28 July 1999

* Regional reference station (located in the Ipswich River watershed)

Table 2. List of perceived problems addressed during the 1999 Merrimack River watershed biomonitoring survey. Specific biomonitoring stations addressing each problem are also listed, as is the sampling methodology employed at each station.

Station	Merrimack River Watershed Issues/Problems	Sampling Method
CB01*	-Unknown toxicity (MA DEP 1999) -Miscellaneous NPS pollution, low dissolved oxygen (MA DEP 1990a)	RBPIII--kick sampling
SB02	-Pathogens, organic enrichment/low dissolved oxygen, pH, nutrients, turbidity (MA DEP 1999) -Potential NPS pollution, "unassessed" for aquatic life	RBPIII--kick sampling
SR01**	-Metals, nutrients, pathogens (MA DEP 1999) -CSO and industrial discharges, stormwater (MA DEP 1990b) -Miscellaneous NPS pollution (MA DEP 1994 unpublished field data)	RBPIII--kick sampling
BB01**	-Pathogens (MA DEP 1999) -Miscellaneous NPS pollution (trash, urban runoff, habitat degradation), impoundment effects (MA DEP 1994 unpublished field data)	RBPIII--kick sampling

* biomonitoring (RBPII - kick sampling) conducted by DEP in 1990
** biomonitoring (RBPIII - artificial substrate sampling) conducted by DEP in 1994

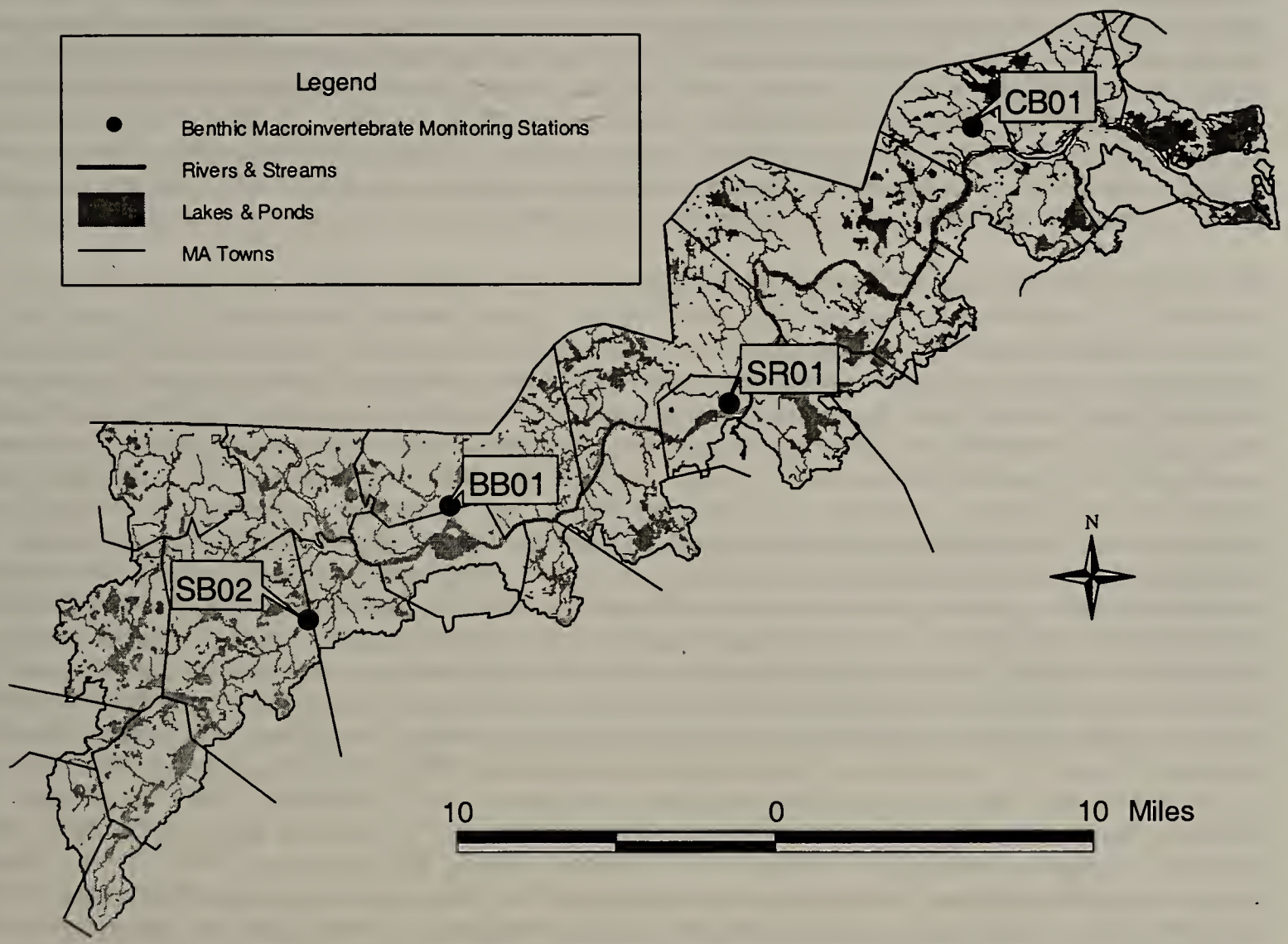


Figure 1. Location of DWM biomonitoring stations for the 1999 Merrimack River watershed survey.

METHODS

Macroinvertebrate Sampling - RBPIII

The macroinvertebrate sampling and processing procedures employed during the 1999 Merrimack River watershed biomonitoring survey are described in the standard operating procedures (Nuzzo 1999), and are based on US EPA Rapid Bioassessment Protocols (RBPs) for wadeable streams and rivers (Barbour et al. 1999). Sampling was conducted by DWM biologists throughout a 100 m reach, in riffle/run areas with fast currents and cobble/gravel substrates—generally the most productive habitats, supporting the most diverse communities in the stream system. Ten kicks in squares approximately 0.46 m x 0.46 m were composited for a total sample area of about 2 m^2. Samples were labeled and preserved in the field with denatured 95% ethanol, then brought to the DEP/DWM lab for further processing.

Habitat Assessments

An evaluation of physical and biological habitat quality is critical to any assessment of ecological integrity (Karr et al. 1986; Barbour et al. 1999). Habitat assessment supports understanding of the relationship between physical habitat quality and biological conditions, identifies obvious constraints on the attainable potential of a site, assists in the selection of appropriate sampling stations, and provides basic information for interpreting biosurvey results (US EPA 1995). Before leaving the sample reach during the 1999 biosurveys, habitat qualities were scored using a modification of the evaluation procedure in Barbour et

al. (1999). The matrix used to assess habitat quality is based on key physical characteristics of the water body and surrounding land use. Most parameters evaluated are instream physical attributes often related to overall land use and are potential sources of limitation to the aquatic biota (Barbour et al. 1999). The ten habitat parameters are as follows: instream cover, epifaunal substrate, embeddedness, sediment deposition, channel alteration, velocity/depth combinations, channel flow status, right and left (when facing downstream) bank vegetative protection, right and left bank stability, right and left bank riparian vegetative zone width. Habitat parameters are scored, totaled, and compared to a regional reference station and/or a site-specific control (upstream reference) station to provide a final habitat ranking.

Macroinvertebrate Sample Processing And Analysis

Macroinvertebrate sample processing entailed distributing whole samples in pans, selecting grids within the pans at random, and sorting specimens from the other materials in the sample until approximately 100 organisms (±10%) were extracted. Specimens were identified to genus or species as allowed by available keys, specimen condition, and specimen maturity. Taxonomic data were analyzed using a modification of Rapid Bioassessment Protocol III (RBP III) metrics and scores (Barbour et al. 1999). Based on the taxonomy, various community, population, and functional parameters, or "metrics", were calculated which allow measurement of important aspects of the biological integrity of the community. This integrated approach provides more assurance of a valid assessment because a variety of biological parameters are evaluated. Deficiency of any one metric should not invalidate the entire approach (Barbour et al. 1999). Metric values for each station were scored based on comparability to the reference station, and scores were totaled. The percent comparability of total metric scores for each study site to those for a selected "least-impacted" reference station yields an impairment score for each site. RBP III analysis separates sites into four categories: non-impacted, slightly impacted, moderately impacted, and severely impacted. Impacts to the benthic community may be indicated by the absence of generally pollution-sensitive macroinvertebrate taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT); dominance of a particular taxon, especially the pollution-tolerant Chironomidae and Oligochaeta taxa; low taxa richness; or shifts in community composition relative to the reference station (Barbour et al. 1999). Those biological metrics calculated and used in the analysis of Merrimack River watershed macroinvertebrate data are listed and defined below (For a more detailed description of metrics used to evaluate benthos data see Barbour et al. [1999]):

1. Taxa richness—a measure based on the number of taxa present. The lowest possible taxonomic level is assumed to be genus or species.

2. EPT Index—a count of the number of genera/species from the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). As a group these are considered three of the more sensitive aquatic insect orders. Therefore, the greater the contribution to total richness from these three orders, the healthier the community.

3. Biotic Index—Based on the Hilsenhoff Biotic Index (HBI), this is an index designed to produce a numerical value to indicate the level of organic pollution. Organisms have been assigned a value ranging from zero to ten based on their tolerance to organic pollution. A value of zero indicates the taxon is highly intolerant of pollution and is likely to be found only in pollution-free waters. A value of ten indicates the taxon is tolerant of pollution and may be found in highly polluted waters. The number of organisms and the individually assigned values are used in a mathematical formula that describes the degree of organic pollution at the study site. The formula for calculating HBI is:

$$HBI = \sum \frac{x_i t_i}{n}$$

where x_i = number of individuals within a taxon
t_i = tolerance value of a taxon
n = total number of organisms in the sample

4. Ratio of EPT and Chironomidae Abundance—The EPT and Chironomidae abundance ratio uses relative abundance of these indicator groups as a measure of community balance. Skewed populations having a disproportionate number of the generally tolerant Chironomidae ("midges") relative to the more sensitive insect groups may indicate environmental stress.

5. Percent Contribution Dominant Taxon—is the percent contribution of the numerically dominant taxon (genus or species) to the total numbers of organisms. A community dominated by few species indicates environmental stress. Conversely, more balance among species indicates a healthier community.

6. Ratio of Scraper and Filtering Collector Functional Feeding Groups—This ratio reflects the community food base. The proportion of the two feeding groups is important because predominance of a particular feeding type may indicate an unbalanced community responding to an overabundance of a particular food source (Barbour et al. 1999). Scrapers predominate when diatoms are the dominant food resource, and decrease in abundance when filamentous algae and mosses prevail. Filtering collectors thrive where filamentous algae and mosses are prevalent and where fine particulate organic material (FPOM) levels are high.

7. Community Similarity—is a comparison of a study site community to a reference site community. Similarity is often based on indices that compare community composition. Most community similarity indices stress richness and/or richness and abundance. Generally speaking, communities with comparable habitat will become more dissimilar as stress increases. In the case of the Merrimack River watershed bioassessments, an index of macroinvertebrate community composition was calculated based on similarity (i.e., affinity) to the reference community, expressed as percent composition of the following organism groups: Oligochaeta, Ephemeroptera, Plecoptera, Coleoptera, Trichoptera, Chironomidae, and Other. The reference site affinity (RSA) metric is calculated as:

$$100 - (\Sigma\, \delta \times 0.5)$$

where δ is the difference between the reference percentage and the sample percentage for each taxonomic grouping. RSA percentages convert to RBPIII scores as follows: <35% receives 0 points; 2 points in the range from 35 to 49%; 4 points for 50 to 64%; and 6 points for ≥65%.

RESULTS AND DISCUSSION

The macroinvertebrate and habitat data collected at each sampling station during the 1999 biosurveys are attached as an Appendix. Included in the taxa list (Table A1) are total organism counts, and the functional feeding group (FG) and tolerance value (TV) of each taxon. In addition, a taxa list of previously unpublished 1994 benthos data collected during DEP's 1994 biosurveys, is included in Table A2 of the Appendix.

A summary table of the RBP III data analyses of the 1999 benthos data, including biological metric calculations, metric scores, and impairment designations, is included in the Appendix as well. Table A3 is the summary table for all Merrimack River watershed stations using Fish Brook (FB00) as the regional reference station. Habitat assessment scores for each station are also included in the summary tables, while a more detailed summary of habitat parameters is shown in Table A4.

The 1999 biomonitoring data for this watershed generally indicate various degrees of nonpoint source-related problems in the tributary stations examined. Urban runoff, habitat degradation, and other forms of nonpoint source pollution compromise water quality and biological integrity throughout the watershed. Improvements in water quality were evident at a few of the tributary stations that have historical biomonitoring data, as reflected in the aquatic communities found there during the 1999 biosurveys.

Merrimack River Watershed

The mainstem Merrimack River is formed in central New Hampshire by the confluence of the Pemigewasset and Winnipesaukee rivers. It flows southward through central New Hampshire for 78 miles and into Massachusetts. Once in Massachusetts, it continues generally southeast for about six miles before veering to the northeast near the city of Lowell, Massachusetts. From here, the Merrimack flows the remaining 44 miles to the city of Newburyport where it empties into the Atlantic Ocean. The drainage basin, fourth largest in New England, has a total of 5,010 square miles in New Hampshire and Massachusetts combined, with 24 percent or 1,200 square miles in Massachusetts.

From the Massachusetts state line to the river's mouth, a distance of 50 miles, the Merrimack drops 90 feet in elevation. Part of this elevation drop includes flow over two major dams in Lawrence and Lowell, Massachusetts. Major canal systems diverting the river flow are also present in Lawrence and Lowell.

Important subwatersheds within the Massachusetts portion of the Merrimack River drainage basin are the Nashua (530 mi^2), Stony Brook (51 mi^2), Sudbury/Assabet/Concord (406 mi^2), and the Shawsheen (72 mi^2) rivers. Other smaller tributaries include Beaver Brook, Spicket River, Little River, and Powwow River.

The three major cities along the Merrimack River in Massachusetts are Lowell, Lawrence, and Haverhill. As historical industrial centers, these cities were once the sources of severe pollution from untreated municipal and industrial wastewater discharges. Today, secondary wastewater treatment facilities are in operation in Lowell, Lawrence, and Haverhill, as well as in Amesbury, Merrimack, and Newburyport. Water quality problems are still evident in the watershed due to combined sewer overflows in Lowell, Lawrence, and Haverhill, to smaller untreated industrial discharges, and to various nonpoint sources.

Fish Brook

The Fish Brook sub-basin lies within the Ipswich River watershed. Its headwaters comprise the drainage area of Mosquito Brook in North Andover and a small, unnamed tributary draining Stiles Pond in Boxford. From the merger of these two tributaries, Fish Brook flows in a generally southeasterly direction through relatively undeveloped wetland and forested areas of Boxford. The stream continues southeastward, draining portions of Boxord State Forest and Boxford Wildlife Sanctuary before joining the Ipswich River in Topsfield.

FB00—Fish Brook, mile point 3.5, upstream from Middletown Road, Boxford, MA. Sampling conducted 28 July 1999.

Habitat

The FB00 sampling reach began approximately 200 m upstream from Middletown Road, in a forested and relatively undeveloped portion of Boxford in the Ipswich River watershed. The partially (approximately 60%) shaded reach consisted of a series of shallow (approximately 0.20 m), short riffles interspersed with deeper (approximately 0.50 m) run areas. Stream width was approximately 6 m. Rocky substrates were prevalent, including an abundance of cobble and pebble, as well as gravel and a fair amount of sand—the latter resulting in occasional small areas of deposition. Instream mosses and emergent macrophytes—most notably burreed (*Sparganium* sp.)—provided additional microhabitat (though not sampled) for macroinvertebrates; however, epifaunal habitat was considered suboptimal. Fish habitat was suboptimal as well, with submerged logs and overhanging shrubs providing the majority of the cover. Both stream banks were well-vegetated and stabilized with an abundance of shrubby and herbaceous vegetation. A diverse assemblage of shrubs and herbaceous growth, consisting of riverbank grape (*Vitis riparia*), rose (*Rosa multiflora*), honeysuckle (*Lornicera* sp.), skunk cabbage (*Symplocarpus foetidus*), Joe-Pye weed, (*Eupatorium* sp.) and ferns, dominated the riparian zone along both banks. Farther from the stream channel riparian vegetation was dominated by a mix of evergreens and hardwoods that included white pine (*Pinus strobus*), red maple (*Acer rubrum*), ash (*Fraxinus americana*), and oak (*Quercus* sp.).

Riparian vegetation extended undisturbed from the left (west) bank, while the wide wooded buffer along the right (east) bank eventually gave way to a large uncultivated pasture.

FB00 received a composite habitat score of 158/200—one of the highest received by a biomonitoring station during the 1999 Merrimack River watershed survey (Table A4). This was the designated regional reference station by virtue of its habitat evaluation, presumed good water quality, and minimal upstream/nearstream land use impacts (i.e., absence of point source inputs, lack of channelization, minimal development or agricultural activity nearby, undisturbed and well-vegetated riparian zone, minimal nonpoint source pollution inputs).

Benthos

This portion of Fish Brook was characterized by a macroinvertebrate assemblage indicating a healthy aquatic community. A richness of 29, including 8 intolerant EPT taxa, was recorded—the most of any biomonitoring station in the survey—and most of the metric values were indicative of clean water and "least-impacted" conditions (Table A3). In particular, those attributes that measure components of community structure (i.e., taxa richness, biotic index, EPT index)—which display the lowest inherent variability among the RBP metrics used (Resh 1988)—scored well, further corroborating the designation as a reference station. A relatively low biotic index (4.81) and high scraper/filterer metric value (1.50) relative to other biomonitoring stations in the survey indicated the dominance of pollution-sensitive taxa among the Fish Brook benthos assemblage, and good overall trophic balance. FB00 received a total metric score of 38 (Table A3).

Cobbler Brook

From its headwaters in the northwestern portion of Merrimack near the New Hampshire border, Cobbler Brook flows in a southeasterly direction through relatively undeveloped and forested areas of Merrimack before reaching the town center. From there it continues in a southeasterely direction, flowing under Interstate 495, before reaching its confluence with the Merrimack River in the Merrimackport section of town. Cobbler Brook has historically received plating waste discharge from *Coastal Metal Finishing* via a feeder stream in the vicinity of Route 110; however, this discharge has since been removed.

CB01—Cobbler Brook, mile point 1.0, upstream from Mill Street, Merrimack, MA. Sampling conducted 20 July 1999.

Habitat

The CB01 sampling reach began approximately 100 m upstream from Mill Street, in a predominantly forested portion of Merrimack with minimal residential development. The mostly (approximately 90%) shaded reach displayed a natural meander, and an abundance of cobble/gravel substrates subjected to well-developed (approximately 0.10 – 0.20 m deep) riffles and runs provided macroinvertebrates with excellent epifaunal habitat. Fish habitat was suboptimal, however, due to shallow water (channel only about half-full) and limited cover. Instream vegetation and algal growth were not observed. Stream width was approximately 4 m.

The majority of both stream banks were well-vegetated and stabilized by an established layer of shrubby and herbaceous growth. The dense layer of rose (*Rosa multiflora*), jewelweed (*Impatiens capensis*), poison ivy (*Rhus radicans*), and Japanese knotweed (*Polygonum cuspidatum*) along the right (south) bank gave way to a wide riparian zone dominated by a mix of hardwoods—most notably red maple (*Acer rubrum*), red oak (*Quercus rubra*), and American beech (*Fagus grandifolia*)—with understory vegetation dominated by dogwood (*Cornus* sp.), witchhazel (*Hamamelis virginiana*), winterberry (*Ilex* sp.), and elderberry (*Sambucus canadensis*). Similar types of herbaceous and shrubby growth provided an adequate buffer from most of the light residential development along the left (north) bank, with the exception of the bottom of the reach, where a steep eroding section of the stream bank with deposits of yard waste (grass clippings, trash) from a nearby home offered potential nonpoint sources of pollution.

Despite the potential for sediment inputs to this portion of the reach, instream deposition and associated embeddedness were minimal. Considerable amounts of instream trash were observed at the bottom of the reach, most likely originating from the adjacent residence.

CB01 received a composite habitat score of 165/200—the highest received by a biomonitoring station during the 1999 Merrimack River watershed survey (Table A4).

Benthos

Despite the optimal habitat relative to reference conditions, the CB01 benthos assemblage received a total metric score (22) that was only 58% comparable to FB00 (Table A3). Low-scoring (score= 0) values for the EPT index metric and the Scrapers/Filterers metric contributed most to the "slightly impacted" bioassessment of CB01. The reduction in pollution-sensitive EPT taxa, as well as the preponderance of filter-feeding caddisflies (e.g., *Cheumatopsyche* sp.; *Hydropsyche betteni* gr.; and *Chimarra* sp.) evident in the CB01 assemblage, indicate that water quality problems related to organic enrichment may persist in this portion of Cobbler Brook. Indeed, the impoundment immediately upstream from the CB02 sampling reach probably provides a significant source of fine organic particulate matter (FPOM) for the SB02 benthic community. More localized nonpoint source-related nutient/organic inputs—most notably yard waste deposits along the steep, eroding north bank—may contribute to the enriched conditions observed in the CB02 sampling reach as well.

In addition, low base-flow (channel only half-full of water) at CB02—and the subsequent elimination of epifaunal habitat—may contribute to reductions in EPT taxa, as many of these organisms are particularly susceptible to substrate exposure and stranding (Minshall 1984). Corroborating the presence of low-flow effects here are the high densities of the chironomids *Parametriocnemus* sp. and *Tvetenia bavarica* gr.—species which are known to survive dry conditions or periods of reduced base-flow (Bode, NY DEC, personal communication 1998).

Community structure and function—at least at the family level—do not appear to have changed greatly at CB02 since the last biosurvey here in 1990. Filter-feeding caddisflies and gathering-collector chironomids continue to dominate the benthic community, though not to the degree observed in 1990, when hydropsychids and chironomids comprised 55% and 38% of the benthos assemblage respectively and contributed to a "moderately impaired" bioassessment (MA DEP 1990a). Possible improvements in community balance at CB02 since 1990 might be at least partially attributable to slight improvements in water quality in this portion of the stream. The removal of the *Coastal Metal Finishing* discharge (now tied-in to the Merrimack POTW [Keohane, MA DEP, personal communication 2001]) in 1990 may have contributed to these improvements. It is also possible that the 1999 biomonitoring effort (10 "kicks" throughout a 100 m reach) entailed the sampling of more, better quality epifaunal habitat than during the 1990 biosurvey (2 adjacent "kicks").

Beaver Brook

Beaver Brook enters Massachusetts having drained considerable portions of southern New Hampshire. As it continues in a southerly direction towards its confluence with the Merrimack River, adjacent land use becomes increasingly developed—first in the mostly residential Collinsville section of Dracut, then more urbanized portions of Dracut and Lowell. Beaver Brook receives the drainage of Double Brook and its heavily developed source water (Long Pond) in Dracut, as well as Peppermint Brook in Dracut before merging with the Merrimack River.

BB01—Beaver Brook, mile point 0.40, downstream from Pleasant Street, Dracut, MA. Sampling conducted 22 July 1999.

Habitat

The BB01 sampling reach began approximately 300 m downstream from Pleasant Street, ending immediately downstream from the confluence with Peppermint Brook. The minimally (approximately 10-20%) shaded reach was approximately 10 m wide with an average depth of about 0.20 m in the riffle/run areas. The numerous deep (approximately 1 m) pools, large boulders, and submerged logs provided fish with excellent cover. Instream vegetation, most notably arrow arum (*Peltandra virginica*) and milfoil (*Myriophyllum* sp.), probably provided additional microhabit as well. Indeed, many pumpkinseed, darters, and shiners were observed in pool areas or inadvertently captured in the kick-net during sampling. Macroinvertebrate habitat, however, was marginal, mainly due to the lack of well-developed riffle areas and a preponderance of gravel and finer (i.e., sand and silt) substrates. And many of the larger, cobble substrates that would normally offer good benthos habitat were left exposed due to the marginal (channel only about half-full) channel flow status. Some snags and other woody debris submerged in riffles areas did provide limited additional microhabitat for macroinvertebrates. Considerable instream sediment deposition in the form of shifting sand, pebble bars, and fine organic/inorganic deposits in pools throughout the reach threaten potential epifaunal habitat and fish habitat. An abundance of trash was observed instream as well. Instream algal growth was moderate, comprised of filamentous forms of green algae mainly in pool areas and in some riffles.

The right (west) stream bank was well-vegetated with herbaceous growth—most notably, various ferns, riverbank grape (*Vitis riparia*), purple loosestrife (*Lythrum salicaria*), and Japanese knotweed (*Polygonum cuspidatum*)—before giving way to a hardwood-dominated forest of maple (*Acer* spp.), oak (*Quercus* sp.), and ash (*Fraxinus* sp.). Banks were relatively stable along the right bank, the exception being near the top of the reach where serious bank erosion was observed. Along the left (east) bank, serious erosion was observed near the top and bottom of the reach. In addition, historical dumping of asphalt along the left bank (possibly originating from an adjacent construction company) near the top of the reach has resulted in removal of much of the riparian vegetation here, as well as deposits of excavated debris directly into the stream channel.

Other nonpoint source inputs enter Beaver Brook via Peppermint Brook, which had a turbid appearance and a petroleum odor during the time of sampling. The presence of a construction and landscaping company adjacent to the mouth of Peppermint Brook has resulted in historical and recent dumping of much trash (including 55 gal. drums), excavation-related debris (e.g., concrete, sand, stones), and other construction materials along the right stream bank and in the stream itself. The effects from nonpoint source pollution in Peppermint Brook appear to be at least partially responsible for observed turbidity and subsequent habitat deterioration in Beaver Brook.
BB01 received a total habitat assessment score of 136/200 (Table A4). This represented 86% comparability to the "least-impacted" habitat conditions encountered at the FB00 reference station. Reduced epifaunal habitat, low base-flow (i.e., marginal channel flow status), and sediment deposition contributed most to point reductions during habitat scoring.

Benthos

BB01 received a total metric score of 22, representing 74% comparability to the FB00 reference station (Table A3). Although this resulted in a bioassessment of "slightly impacted," many of the metric values scored as well as those for the FB00 benthos assemblage. Indeed, pollution sensitive taxa were well-represented at BB01, as indicated by an EPT index higher than at FB00 (Table A3). Contributing most to metric score reductions was the Scrapers/Filterers metric value (score= 0), the result of high densities of net-spinning caddisflies (e.g., Hydropsychidae; Philopotamidae) (Table A1). These filter-feeders are probably afforded an abundant FPOM food supply from the impoundments immediately upstream from the BB01 sampling reach, extensive wetlands near the Massachusetts-New Hampshire border, and possibly Peppermint Brook as well. Long Pond (via Double Brook), in particular, may be a source of nutrient loads and associated FPOM to this portion of Beaver Brook, as this waterbody is on the 303(d)

list of impaired waters due to noxious aquatic vegetation (MA DEP 1999). The philopotamid and hydropsychid caddisflies, however, did not occur at the densities observed during the last biomonitoring survey conducted here in 1994, when they were hyperdominant and comprised over 85% of the assemblage (Table A2). In addition, total taxa richness and EPT richness were higher at BB01 in 1999 than 1994—possibly indicative of slight improvements in water quality here since the 1994 biosurvey.

Nevertheless, serious habitat degradation continues to threaten biological integrity in this portion of Beaver Brook. The greatest threat to the resident benthic community at BB01 may be instream sedimentation. Sand and other fine sediments drastically reduce macroinvertebrate microhabitat by filling the interstitial spaces of epifaunal substrates. In addition, the filling of pools with sediment reduces fish cover and may be detrimental to fish egg incubation and survival. Sediment inputs probably originate from numerous sources in this portion of the watershed—the upstream road crossing, Peppermint Brook, a sand and gravel operation just upstream, and the seriously eroding stream banks throughout much of the sampling reach—all may contribute to the instream deposition observed at BB01. In addition, the effects of runoff are probably exacerbated by the removal of much of the vegetative riparian buffer along the east bank of the sampling reach.

In addition to sediments, much anthropogenic debris exists throughout the sampling reach, further compromising habitat and threatening water quality here. In particular, the adjacent construction company appears to be the source of much of the instream and riparian trash deposits in Beaver Brook and near the confluence with Peppermint Brook. Petroleum odors and instream turbidity at BB01—apparently originating from Peppermint Brook—further corroborate the threat to aquatic life and water quality here.

Stony Brook

Stony Brook originates between Ayer and Littleton as Beaver Brook (different from the Beaver Brook described above). From the outlet of Forge Pond in Westford, it flows generally northeast through Littleton, Westford, and North Chelmsford where it enters the Merrimack River just past the Route 3 highway crossing. In its 22 mile length, it drains a moderately developed area of approximately 51 square miles and falls 200 feet. Dams create many impoundments along its entire length. The mainstem is fed by numerous small streams along its path to the Merrimack River. The Stony Brook sub-basin also includes a number of lakes and ponds—the largest being Forge, Keyes, Nabnasset, and Long Sought-for ponds.

SB02—Stony Brook, mile point 3.30, downstream from Brookside Road, Westford, MA. Sampling conducted 20 July 1999.

Habitat

The SB02 sampling reach began approximately 100 m downstream from Brookside Road. The partially (>50%) shaded reach meandered through a wooded area of ash (*Fraxinus* sp.) and maple (*Acer* sp.). Along the margins of both stream banks, dense herbaceous growth—especially royal fern (*Osmunda regalis*), barberry (*Berberis* sp.) and purple loosestrife (*Lythrum salicaria*)—provided bank stability and a good riparian buffer. Shrubs were an important riparian component as well, with dogwood (*Cornus* sp.), *Viburnum* sp., and riverbank grape (*Vitis riparia*) the dominant species. Instream vegetation and algal growth were minimal, composed mainly of rooted submergent pondweed (*Potamogeton* sp.), and both filamentous and matted forms of green algae respectively.

Epifaunal substrates were considered optimal as benthos habitat, albeit at the lower-scoring end of that parameter due to the shallow (approximately 0.10 – 0.20 m) nature of the riffle/run areas at the time of sampling and the small size (mainly small cobble, gravel, and sand) of the inorganic substrate components. Fish habitat was considered suboptimal and was mostly confined to the middle of the reach, where deep (approximately 0.75 m) pools and submerged woody debris provided good cover. Stream width was approximately 3 – 5 m.

Nonpoint source pollution—especially sediment deposition—seriously compromises instream fish and benthos habitat potential in this portion of Stony Brook. Significant deposits of sand and finer sediments were observed throughout the reach, eliminating productive riffle habitat and filling in pool areas. While the Brookside Road crossing is one obvious source of potential sediment inputs to the SB01 reach, other upstream sources may exist. Numerous sand and gravel pits—often located immediately adjacent to the stream—are present in the Stony Brook sub-basin; although, none occur in the immediate area. Other localized nonpoint source pollution observed at SB01 included trash deposits (wood, glass, tires, plastics), observed throughout the sampling reach and probably originating from upstream road crossings.

The SB02 biomonitoring reach received a total habitat assessment score of 145/200, representing 92% comparability to the "least-impacted" habitat conditions encountered at the FB00 reference station (Table A4). Sediment deposition, substrate embeddedness in riffle/run areas, and reduced base-flow (i.e., marginal channel flow status) contributed most to reductions in habitat scores.

Benthos

Despite habitat comparable (92%) to the reference condition, the SB02 benthos assemblage received a total metric score of only 20, representing 53% comparability to the reference station at FB00 and resulting in a "slightly impacted" bioassessment (Table A3). The dominance of the community by relatively few taxa, particularly the filter-feeding Hydropsychidae (an unusually high density of the filter-feeding mussel, *Eliptio complanata* was observed at SB02 as well) indicates an unbalanced community responding to an overabundance of fine particulate organic matter (FPOM) in the water column. Significant deposits of FPOM were also observed on much of the instream substrates. That the assemblage is dominated by filter-feeders is not surprising, as the impounded nature of much of Stony Brook no doubt results in a constant source of suspended FPOM; however, the high densities represented by the hydropsychids are somewhat disconcerting and indicative of the effects of moderate enrichment. Typically, in lentic systems such as the upstream impoundments, the primary source of organic matter is autochthonous (produced within the system), with secondary inputs of allochthonous (transported into the system from someplace else) materials from shoreline vegetation and fluvial inputs (Wetzel 1975, Merritt et al. 1984). Phytoplankton production—and to a lesser extent, littoral vascular plant production—and associated dissolved organic matter (DOM), are the primary source of autochthonous matter (Wetzel 1975). It is the physical-chemical flocculation (nonbiological) of this DOM and/or other biological processes that leads to the formation of FPOM, the primary nutrition resource utilized by filter-feeders (Wetzel 1975). While FPOM production in lotic systems is primarily a result of the processing of Course Particulate Organic Material (CPOM) contributed by aquatic shredders, the high concentration of FPOM in stream systems immediately below pond and reservoir outlets has mainly lentic origins. If these lentic systems are subjected to increasingly eutrophic conditions the resulting effects of enrichment (i.e., increased algal, plant, and DOM production) can be seen not only in the lentic fauna, but also in the lotic aquatic communities immediately downstream.

The enrichment effects (e.g., dominance of filter-feeders, displacement of scrapers) reflected in the SB02 benthic community are probably most directly related to the productive nature of various upstream waterbodies in the Stony Brook subwatershed. The entire length of Stony Brook from the outlet of Forge Pond to SB02 is currently on the 303(d) list of impaired waters for organic enrichment and associated low dissolved oxygen (MA DEP 1999). In addition, Stony Brook's headwater stream—Beaver Brook—is impaired by nutrients and organic enrichment. Not surprisingly, Mill and Forge ponds—receiving waters for Beaver Brook—are impaired by noxious and non-native aquatic vegetation respectively (MA DEP 1999). It is worth mentioning that Mill Pond receives the effluent from the NPDES-permitted discharge of Veryfine Products, Inc. in Littleton via a small tributary (Reedy Meadow Brook).

Eutrophic waterbodies upstream, as well as various nonpoint source-related nutrient/organic loadings to Stony Brook, appear most responsible for biological impairment and suspect water quality at SB02. In addition, instream deposits of fine organic (FPOM) and inorganic (sand) materials threaten habitat quality and biological potential here as well. These fine materials can be deleterious because they can reduce light penetration—and consequently plant growth (instream aquatic vegetation and periphyton cover were

minimal at SB02), smother hard surfaces, and fill interstices within the substrate (Wiederholm 1984). Resident biota at SB02, then, may be subsequently affected by obstructions to food collection or respiration caused by fine deposits of organic/inorganic material.

Spicket River

Formed by the drainages of Arlington Hill Reservoir, Providence Hill Brook, and Captain Pond Brook in southern New Hampshire, the Spicket River flows south towards the Massachusetts border. Upon entering Massachusetts it continues in a southeasterly direction, draining highly urbanized portions of Methuen and Lawrence before joining the Merrimack River just upstream from Interstate 495. Water quality has historically been compromised along much of the Spicket River, especially in Lawrence, where numerous industrial and stormwater discharges, and a combined sewer overflow (CSO) discharge exist (MA DEQE 1985, MA DEP 1990b). Water quality remains suspect in the Spicket River—currently the entire length of the river in Massachusetts (i.e., New Hampshire state line [Methuen] to confluence with Merrimack River, Lawrence, Miles 6.40 – 0.00) does not meet state surface water quality standards for nutrients, pathogens, and metals—resulting in its inclusion on the most recent Massachusetts Section 303(d) List of Waters (MA DEP 1999).

SR01—Spicket River, mile point 0.25, downstream from General Street, Lawrence, MA. Sampling conducted 22 July 1999.

Habitat

The SR01 sampling reach was located approximately 200 m downstream from General Street, in a highly industrialized and channelized (both a free-standing stone wall and the foundation of a mill building has replaced the right/south bank; "rip-rap" is deposited along left/north bank) portion of the Spicket River. The minimally (<5%) shaded reach was approximately 6 – 8 m wide, with depth ranging from 0.20 – 0.30 m in riffle/run areas and up to 0.75 m deep in the pools. Swift current velocity, coupled with an abundance of cobble and pebble substrates offered excellent epifaunal habitat for macroinvertebrates. Fish habitat was marginal at best, however, due to an obvious lack of cover. In fact, instream trash (metal, plastic, glass) provided most of the "stable" fish habitat. The riparian vegetative zone was extremely limited along the left bank, with a few sumac (*Rhus* sp.) shrubs and silver maple (*Acer saccharinum*) trees, purple loosestrife (*Lythrum salicaria*), poison ivy (*Rhus radicans*), and Japanese knotweed (*Polygonum cuspidatum*) providing only a very thin riparian buffer from an adjacent parking lot. Serious bank erosion has resulted in numerous bare spots along this bank, and a large pile of trash was observed near the top of the reach. Riparian vegetation was completely removed along the right (south) bank, a result of the channelized conditions mentioned above. A large parking lot adjacent to the right bank parallels much of the reach. Instream vegetation consisted of aquatic mosses and filamentous green algae—each covering about 30% of the reach.

The narrow vegetative buffer, coupled with the close proximity of adjacent industrial/commercial activity, increases the potential for nonpoint source pollution inputs to the SR01 reach. Occasional deposits of sand were observed near the top of the sampling reach—origins of instream sedimentation are unknown; however, serious erosion along the steep left (south) bank, parking lots, and numerous stormdrains entering the stream along the right (north) bank are potential sources. Slightly turbid instream conditions were observed.

SR01 received a total habitat assessment score of 115/200, representing 73% comparability to the "least-impacted" habitat conditions encountered at the FB00 reference station (Table A4). This was the lowest habitat score received by a biomonitoring station during the 1999 Merrimack River watershed survey, with poor instream fish cover, sediment deposits, severe channelization, and reduced riparian zone width negatively affecting the habitat score.

Benthos

SR01 received a total metric score of 32, representing 84% comparability to the reference condition at FB00 (Table A3). This was the only study site in the 1999 Merrimack River watershed biomonitoring survey found to be "non-impacted" for biological condition. Despite the obvious habitat limitations and potential nonpoint source pollution inputs in this portion of the Spicket River, the SR01 macroinvertebrate community was surprisingly diverse. Both total taxa richness and EPT richness were highly comparable (i.e., score= 6) to the reference assemblage at FB00; and in terms of overall community composition, SR01 displayed the highest affinity (68%) to FB00 than any other biomonitoring station in the 1999 survey (Table A3). EPT/Chironomidae and Percent Dominant Taxon metrics actually performed better than those for the reference station (Table A3)—the low percentage (20%) for the latter metric value indicating good overall balance among the SR01 benthic community.

Community structure and function among the SR01 benthos assemblage was markedly different in 1999 than during the previous biomonitoring survey here. In 1994, the sample was dominated by taxa highly tolerant of conventional organic pollution—most notably, gathering-collector forms of naidid and echytraeid worms, as well as numerous tolerant chironomids (Table A2). The hyperdominance of these groups contributed to the highest biotic index (8.61 when based on 1994 tolerance values; 8.54 when based on current tolerance values) observed during the 1994 survey (Table A2). Pollution tolerant worms were conspicuously absent from the 1999 benthos sample here, and the biotic index was considerably lower (5.92 when based on current tolerance values). While a direct comparison of data between the two surveys may be inadvisable, due to differing flow conditions and sampling/sample processing methodologies (i.e., rock basket samplers employed in 1994; kick sampling in 1999; data analyses based on 200-organism subsample in 1994; 100-organism subsample in 1999), water quality may have improved dramatically here since the 1994 survey.

According to Kevin Brander (MA DEP/ Division of Municipal Services, personal communication 2001), who manages the CSO abatement programs in the Merimack River watershed, the Greater Lawrence Sanitary District (GLSD)—as part of their abatement work—was required to implement by 1997 (and has) CSO measures known as the "Nine Minimum Controls." This entails operating and maintaining the existing CSO system and treatment facility in such a way that CSO impacts are minimized to the greatest extent possible. Maintenance includes raising regulator and weir heights in the overflow structures and maximizing flows to the GLSD treatment facility. This abatement work may have contributed to the improved water quality and biological conditions observed at SR02 during the 1999 biosurvey compared to 1994, when the outfall might have been discharging more often, with more volume, and possibly during dry weather. In addition, a permitted upstream power plant discharge to the Spicket River has been eliminated since the 1994 biosurvey (Cashins, MA DEP/ Northeast Regional Office, personal communication 2001).

Instream and riparian habitat degradation—particularly the dumping of trash, riparian disturbances (e.g., bank erosion, removal of riparian vegetation), and sediment inputs from adjacent impervious surfaces—continues to threaten biological potential at SR01. The highly urbanized nature of this portion of the Spicket River subwatershed makes the control and/or elimination of these perturbations somewhat problematic.

SUMMARY/ RECOMMENDATIONS

Fish Brook, Boxford, MA (FB00)

Benthos: Reference condition
Habitat: Reference condition

Since the 1999 biosurvey here, new home construction has occurred in the pasture immediately adjacent to the FB00 sampling reach. This may not only pose a threat to riparian/instream habitat potential and the health of resident biota in this portion of Fish Brook, but compromise FB00's status as a reference condition for future biomonitoring surveys in the Ipswich and nearby (i.e., Parker and Merrimack River watersheds) watersheds. It is imperative that biomonitoring (macroinvertebrates and fish) be conducted here during the next (i.e., 2004) round of "year 2" monitoring activities in the "yellow" (i.e., Merrimack) basins.

Cobbler Brook, Merrimack, MA (CB02)

Benthos: Slightly Impacted (58% of reference score)
Habitat: >100% of reference score

Water quality degradation resulting from organic enrichment—and probably to a lesser degree habitat constraints related to riparian disturbances and seasonal low base-flow—compromise biological integrity at CB02. Impoundment effects, localized nonpoint source pollution, and unknown anthropogenic perturbations originating upstream (possibly in the vicinity of downtown Merrimack) may pose a threat to biological potential in this portion of Cobbler Brook.

Outreach efforts are recommended to educate nearby residents on how improper yard waste disposal can impact aquatic life "in their own back yard," as well as the importance of maintaining a riparian buffer zone. In addition, local clean-up efforts to remove instream trash and debris should be encouraged.

While toxic effects—possibly attributable to the *Coastal Metal Finishing* discharge—are no longer evident here, as was the case during the 1990 biosurvey, depleted oxygen levels may contribute to the reduction of pollution-sensitive EPT taxa observed during the 1999 survey. Biomonitoring is recommended here during the next DEP Merrimack River watershed survey in 2004. Fish population sampling, which has not historically been performed by DEP in this subwatershed, should accompany the macroinvertebrate sampling effort. In addition, monitoring physico-chemical parameters—especially dissolved oxygen and pH—may aid in the interpretation of future biomonitoring data collected here.

Beaver Brook, Dracut, MA (BB01)

Benthos: Slightly Impacted (74% of reference score)
Habitat: 86% of reference score

Upstream impoundments (e.g., Long Pond) probably account for the enriched conditions reflected in the aquatic community at BB01. In addition to water quality constraints, habitat degradation (especially riparian) significantly compromises biological integrity in this portion of Beaver Brook.

Immediately following the 1999 biosurvey here, DWM notified DEP's Northeast Regional Office (NERO) regarding the observed dumping of construction materials along the BB01 sampling reach and near the Peppermint Brook confluence. As a result, NERO has since filed a Request for Information Regarding a Complaint with the Dracut Board of Health. If one has not been conducted already, a site visit to the construction/excavating company adjacent to the BB01 reach is recommended to determine the extent that the property is a source (though other upstream sources no doubt exist) of sediment and trash inputs to this portion of the river. In addition, the EOEA Merrimack River Watershed Team may wish to contact

either the Dracut Board of Health or DEP/ NERO to determine if efforts have since been made to remedy the situation. A site visit to the sand and gravel operation located upstream near the Long Pond Park portion of Dracut may be warranted as well. Improvements to the riparian zone along the east bank of the reach would be beneficial in alleviating the effects of nonpoint source inputs. Streambank stabilization and restoration of a riparian buffer may help to reduce the effects of road and parking lot runoff in this portion of Beaver Brook.

Biomonitoring is recommended here during the next DEP Merrimack River watershed survey in 2004. Fish population sampling, which has not historically been performed by DEP in this subwatershed, should accompany the macroinvertebrate sampling effort. In addition, the origins of suspect water quality in Peppermint Brook should be investigated—water quality monitoring may help to isolate potential sources of petroleum, turbidity, sediments, and other environmental perturbations.

Stony Brook, Westford, MA (SB02)

Benthos: Slightly Impacted (53% of reference score)
Habitat: 92% of reference score

Eutrophic conditions of upstream impoundments (e.g., Forge and Mill ponds), as well as direct nutrient/organic loadings to Stony Brook itself probably account for the organically enriched conditions reflected in the aquatic community at SB02. In addition to water quality constraints, habitat degradation (especially instream deposition) probably compromises biological integrity here as well—though to a lesser degree. An investigation of land-use and possible nonpoint source pollution along Stony Brook upstream from SB02 may help to isolate sources of nonpoint source-related stressors. A stream clean-up effort would address the trash that apparently enters the river from the Brookside Road crossing, and further dumping of trash should be strongly discouraged. In addition, a review of the Veryfine Products, Inc. NPDES permit (no. MA0004936) requirements—most recently modified in 1998—is recommended, as wastewater discharged from this facility may contribute to the eutrophic conditions documented in Mill Pond and/or Beaver Brook.

Biomonitoring is recommended here during the next DEP Merrimack River watershed survey in 2004. Fish population sampling, which has not historically been performed by DEP in this subwatershed, should accompany the macroinvertebrate sampling effort.

Spicket River, Lawrence, MA (SR01)

Benthos: Non-impacted (84% of reference score)
Habitat: 73% of reference score

Despite habitat constraints attributable to the urbanized nature of this subwatershed, biological integrity has likely improved here since the last DEP biosurvey conducted in 1994, when organisms highly tolerant of organic pollution dominated the benthic community and indicated serious water quality degradation. CSO abatement work required of GLSD may have contributed to improvements in water quality in this portion of the river.

While it may be difficult to eliminate or isolate some sources of urban runoff (stormwater, road/parking lot runoff, riparian disturbances) that threaten habitat and biological quality at the SR01, streambank stabilization and restoration of an adequate riparian buffer may help to alleviate the effects of some nonpoint source inputs to this portion of the river. In addition, a stream clean-up effort would greatly improve the aesthetic nature of this segment of the Spicket River.

Biomonitoring (macroinvertebrates and fish) is strongly recommended here during the next DEP Merrimack River watershed survey in 2004, so as to continue to monitor the CSO abatement efforts of GLSD and any other river improvement measures that may take place.

LITERATURE CITED

Barbour, M. T., J. B. Stribling, and J. R. Carr. 1995. The multimetric approach for establishing biocriteria and measuring biological condition. pp. 63-80. *in* W. S. Davis and T. P. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL. 415 p.

Barbour, M. T., J. Gerritsen, B. D. Snyder, and J. B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish. Second Edition. EPA 841-B-99-002. Office of Water, US Environmental Protection Agency, Washington, DC. 151 p. + appendices

Fiorentino, J.F. 1999. CN 7.0 Quality Assurance Project Plan for 1999 Benthic Macroinvertebrate Biomonitoring. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA. 24 p.

Hughes, R. M. 1989. Ecoregional Biological Criteria. Water Quality Standards for 21st Century. 147-151.

Karr, J. R., K. D. Fausch, P. L. Angermeier, P. R. Yant, and I. J. Schlosser. 1986. Assessing Biological Integrity in Running Waters: A Method and Its Rationale. Special Publication 5. Illinois Natural History Survey. Champaign, IL. 28 p.

MA DEQE. 1985. A Report on 1985 Water Quality Conditions and Pollution Abatement in the Merrimack River Basin in Massachusetts. Massachusetts Department of Environmental Quality Engineering, Division of Water Pollution Control. Westborough, MA. 140 p.

MA DEP 1990a. Assessment of Unassessed Waters in the Merrimack Basin Using Rapid Biological Monitoring. Massachusetts Department of Environmental Protection, Division of Water Pollution Control. Westborough, MA. 88 p.

MA DEP 1990b. Merrimack River 1989 Water Quality, Wastewater Treatment Plant and Water treatment Plant Discharge Survey Data, and Analysis. Massachusetts Department of Environmental Protection, Division of Water Pollution Control. Westborough, MA. 64 p.

MA DEP. 1999. Massachusetts Section 303(d) List of Waters – 1998. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA. 129 p.

Merritt, R. W., K. W. Cummins, and T. M. Burton. 1984. The role of aquatic insects in the processing and cycling of nutrients. pp. 134-163. *in* V. H. Resh and D. M. Rosenberg (eds.). The Ecology of Aquatic Insects. Praeger Publishers, New York, NY. 625 p.

Minshall, G. W. 1984. Aquatic insect-substratum relationships. pp. 358-400 *in* V. H. Resh and D. M. Rosenberg (eds.). The Ecology of Aquatic Insects. Praeger Publishers, New York, NY. 625 p.

Nuzzo, R. 1999. Standard Operating Procedures (Working Draft): Water Quality Monitoring in Streams Using Aquatic Macroinvertebrates. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA. 8 p.

Peckarsky, B. L., P. R. Fraissinet, M. A. Penton, and D. J. Conklin, Jr. 1990. Freshwater macroinvertebrates of northeastern North America. Comstock Publishing Assoc. Ithaca, NY. 442 p.

Resh, V. H. 1988. Variability, accuracy, and taxonomic costs of rapid bioassessment approaches in benthic biomonitoring. Presented at the 36th annual North American Benthological Society meeting at Tuscaloosa, Alabama, 17-20 May 1988.

US EPA. 1995. Generic Quality Assurance Project Plan Guidance for Programs Using Community Level Biological Assessment in Wadeable Streams and Rivers. U.S. Environmental Protection Agency, Office of Water. 71 p.

Wetzel, R. G. 1975. Limnology. W. B. Saunders Co., Philadelphia, PA. 743 p.

Wiederholm, T. 1984. Responses of aquatic insects to environmental pollution. pp. 508-557. *in* V. H. Resh and D. M. Rosenberg (eds.). The Ecology of Aquatic Insects. Praeger Publishers, New York, NY. 625 p.

APPENDIX

Macroinvertebrate taxa lists, RBPIII analyses, and Habitat evaluations

Table A1. Species-level taxa list and counts, functional feeding groups (FG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 1999 Merrimack River watershed survey between 20 and 28 July 1999. Refer to Table 1 for a complete listing and description of sampling stations.

Taxon	FG[1]	TV[2]	FB00[3]	BB01	CB01	SB02	SR01
Pisidiidae	FC	6	5				
Hydrobiidae	SC	8		1			2
Planorbidae	SC	6				1	
Lumbricina	GC	8			2	1	
Nais alpina	GC	8					1
Nais communis	GC	8		1	1	1	1
Pristinella osborni	GC	10				1	2
Lumbriculus variegatus	GC	5	3			1	
Erpobdella sp.	PR	8			1		
Caecidotea communis	GC	8			1		
Gammarus sp.	GC	6	33	13			20
Hydrachnidia	PR	6		1			5
Baetidae	GC	4				4	3
Baetidae (with cerci only)	GC	6		3			
Baetidae (with terminal filament)	GC	6		1			
Baetis sp. (with cerci only)	GC	6					5
Baetis sp. (with terminal filament)	GC	6				3	5
Stenonema sp.	SC	3	2	1		2	
Isonychia sp.	GC	2				1	
Tricorythodes sp.	GC	4				2	
Hansonoperla sp.	PR	1	2				
Leuctra sp.	SH	0	7				
Perlesta sp.	PR	5	1				
Nigronia sp.	PR	0			1	1	
Helicopsyche sp.	SC	3		1			
Cheumatopsyche sp.	FC	5		6	5		9
Hydropsyche sp.	FC	4	1				3
Hydropsyche betteni gr.	FC	6		35	29	49	4
Hydropsyche morosa gr.	FC	6				12	2
Macrostemum zebratum	FC	3		7		1	
Ochrotrichia sp.	GC	4				1	
Lepidostoma sp.	SH	1		1			1
Chimarra sp.	FC	4		8	11	4	1
Dolophilodes sp.	FC	0		3			
Neophylax sp.	SC	3	1		2		
Oecetis sp.	PR	5	1				
Psilotreta sp.	SC	0	1				
Microcylloepus sp.	GC	3	2				
Optioservus sp.	SC	4	5	2			

Table A1. Continued.

Taxon	FG[1]	TV[2]	FB00[3]	BB01	CB01	SB02	SR01
Oulimnius latiusculus	SC	4		2			
Promoresia tardella	SC	2	6				
Stenelmis sp.	SC	5	1		5	1	
Psephenus herricki	SC	4	1				
Forcipomyia sp.	SC	6			1		
Chironomus sp.	GC	10				1	
Microtendipes pedellus gr.	FC	6	3	2			1
Microtendipes rydalensis gr.	FC	6	1				
Phaenopsectra sp.	GC	7	1				
Polypedilium fallax	SH	6	1				
Polypedilum flavum	SH	6		10			3
Polypedilum tritum	SH	6	1				
Micropsectra sp.	GC	7	8		2		
Rheotanytarsus distinctissimus gr.	FC	6					1
Rheotanytarsus exiguus gr.	FC	6					8
Tanytarsus sp.	FC	6	2	1	1		1
Stempellinella sp.	GC	2	2				
Diamesa sp.	GC	5					2
Cricotopus sp.	SH	7		1			
Cricotopus annulator	SH	7					5
Cricotopus/Orthocladius sp.	GC	7					1
Heterotrissocladius sp.	GC	4			1		
Nanocladius sp.	GC	7				1	1
Orthocladius sp.	GC	6					2
Parametriocnemus sp.	GC	5	1		16		
Rheocricotopus sp.	GC	6				3	1
Tvetenia bavarica gr.	GC	5	1	1	13		
Tvetenia vitracies gr.	GC	5					1
Conchapelopia sp.	PR	6	1		2	2	
Nilotanypus sp.	PR	6		1		1	
Thienemannimyia sp.	PR	6	1		1		1
Clinocera sp.	PR	6			1		
Hemerodromia sp.	PR	6		1	1	2	7
Simulium sp.	FC	5		1			
Tipulidae	SH	5			1		
Dicranota sp.	PR	3	2				
TOTAL			97	104	98	96	99

[1] Functional Feeding Group (FG) lists the primary feeding habit of each species and follows the abbreviations: SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR-Predator.
[2]Tolerance Value (TV) is an assigned value used in the calculation of the biotic index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant.
[3] Reference station; Located in the Ipswich River watershed and sampled 28 July 1999.

Table A2. Species-level taxa list and counts, functional feeding groups (FG), and tolerance values (TV) for macroinvertebrates collected from rock basket samplers in stream sites during the 1994 Merrimack River watershed survey. Samplers were deployed 3 August 1994 and retrieved 16 September 1994. Stations were located at: Beaver Brook, downstream from Pleasant Street, Dracut, MA (MRI45-03); and Spicket River, downstream from General Street, Lawrence, MA (MRI51-03).

Taxon	FG[1]	TV[2]	MRI45-03	MRI51-03
Amnicola limosa	SC	5	2	
Enchytraeidae	GC	10		29
Tubificidae (immature, without capilliform chaetae)	GC	10		2
Tubificidae (immature, with capilliform chaetae)	GC	10		1
Nais behningi	GC	6		2
Nais communis	GC	8		2
Pristina aequiseta	GC	8		4
Pristina leidyi	GC	8		1
Pristinella acuminata	GC	10		1
Pristinella jenkinae	GC	10		87
Pristinella osborni/sima	GC	10		5
Gammarus sp.	GC	6		7
Gammarus fasciatus	GC	6		7
Hydracarina	PR	6	2	
Baetidae	GC	4	1	
Acentrella sp.	SC	4	2	1
Baetis sp.	GC	6	1	
Acroneuria sp.	PR	0	1	
Chimarra sp.	FC	3	50	
Neureclipsis sp.	FC	4	1	
Cheumatopsyche sp.	FC	7	37	2
Hydropsyche morosa gr.	FC	6	55	3
Macrostemum sp.	FC	4	18	
Hydroptila sp.	GC	6	4	
Simulium sp.	FC	4	1	
Simulium vittatum	FC	9		3
Tanypodinae	PR	7	1	
Diamesinae	GC	2		1
Potthastia longimana gr.	GC	7		1
Corynoneura sp.	GC	6	2	
Cricotopus sp.	GC	7		1
Cricotopus/Orthocladius sp.	GC	7		1
Cricotopus bicinctus	GC	7	1	2
Cricotopus tremulus gr.	SH	7		14
Cricotopus vierriensis	SH	7		2
Orthocladius sp.	GC	6		1
Parametriocnemus sp.	GC	4	1	
Rheocricotopus sp.	GC	6		1
Thienemanniella sp.	GC	6		1

Table A2. Continued.

Taxon	FG[1]	TV[2]	MRI45-03	MRI51-03
Tvetenia vitracies gr.	GC	5	1	
Polypedilum sp.	SH	6		1
Polypedilum convictum	SH	5	4	10
Rheotanytarsus exiguus gr.	FC	6	1	10
Tanytarsus sp.	FC	7		1
Hemerodromia sp.	PR	6		2
TOTAL			187	206
HBI based on 1994 tolerance values			5.09	8.61
HBI based on current tolerance values			4.88	8.54

[1] Functional Feeding Group (FG) lists the primary feeding habit of each species and follows the abbreviations: SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR-Predator.
[2]Tolerance Value (TV) is an assigned value used in the calculation of the biotic index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for organisms very tolerant. Tolerance values listed here are based on 1994 assignments; Tolerance values have been revised since 1994 for some taxa.

Table A3. Summary of RBP III data analyses for macroinvertebrate communities sampled during the Merrimack River watershed survey between 20 July and 28 July 1999. Shown are the calculated metric values, metric scores (in italics) based on comparability to the reference station (FB00), and the corresponding assessment designation for each biomonitoring station. Refer to Table 1 for a complete listing and description of sampling stations.

STATION #	FB00		CB01		BB01		SB02		SR01	
STREAM	Fish Brook		Cobbler Brook		Beaver Brook		Stony Brook		Spicket River	
HABITAT SCORE	158		165		136		145		115	
TAXA RICHNESS	29	*6*	21	*0*	24	*0*	29	*0*	26	*6*
BIOTIC INDEX	4.81	*6*	5.35	*0*	5.26	*0*	5.69	*0*	5.92	*4*
EPT INDEX	8	*6*	2	*0*	10	*0*	10	*0*	0	*6*
EPT/CHIRONOMIDAE	0.70	*6*	1.31	*6*	4.13	*6*	9.88	*6*	1.18	*6*
SCRAPERS/FILTERERS	1.50	*6*	0.17	*0*	0.11	*0*	0.08	*0*	0.07	*0*
COMMUNITY SIMILARITY (RSA)	100%	*6*	42%	*2*	42%	*2*	22%	*0*	68%	*6*
% DOMINANT TAXON	30%	*2*	30%	*4*	34%	*2*	51%	*0*	20%	*4*
TOTAL METRIC SCORE		*38*		*22*		*28*		*20*		*32*
% COMPARABILITY TO REFERENCE STATION	**100%**		**58%**		**74%**		**58%**		**84%**	
BIOLOGICAL CONDITION-DEGREE IMPAIRMENT	**REFERENCE**		**SLIGHTLY IMPACTED**		**SLIGHTLY IMPACTED**		**SLIGHTLY IMPACTED**		**NON-IMPACTED**	

Table A4. Habitat assessment summary for macroinvertebrate biomonitoring stations sampled during the 1999 Merrimack River watershed survey. For primary parameters, scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For secondary parameters, scores ranging from 9-10 = optimal; 6-8 = suboptimal; 3-5 = marginal; 0-2 = poor. Refer to Table 1 for a complete listing and description of sampling stations.

STATION	FB00	CB01	BB01	SB02	SR01
PRIMARY PARAMETERS (range is 0-20)					
INSTREAM COVER	15	14	18	14	8
EPIFAUNAL SUBSTRATE	13	16	10	16	18
EMBEDDEDNESS	15	16	16	13	16
CHANNEL ALTERATION	16	20	16	16	8
SEDIMENT DEPOSITION	15	18	6	6	16
VELOCITY-DEPTH COMBINATIONS	10	14	15	14	9
CHANNEL FLOW STATUS	16	8	8	9	10
SECONDARY PARAMETERS (range is 0-10 for each bank)					
BANK VEGETATIVE PROTECTION	10 10	9 10	7 10	10 10	8 2
BANK STABILITY	10 8	8 8	7 8	9 9	6 10
RIPARIAN VEGETATIVE ZONE WIDTH	10 10	9 10	7 8	10 10	3 0
TOTAL SCORE	**158**	**165**	**136**	**145**	**115**
%COMPARABILITY TO REFERENCE (FB00)	**100%**	**>100%**	**86%**	**92%**	**73%**

APPENDIX D – SUMMARY OF NPDES and WMA PERMITTING INFORMATION, MERRIMACK RIVER BASIN

Table D1. Merrimack River Basin Municipal Surface Wastewater Discharges.

Permitee	NPDES #	Issuance	Flow (MGD)	Treatment	Special Conditions	Dilution Factor*	Special Notes
Amesbury WWTP, Amesbury	MA0101745	1998	1.9	2ndry	IPP	Tidal	#001 treated sanitary and industrial wastewater, to Merrimack River
Andover WTP, Andover	MAG640058	8/30/01	0.8	WTP			to Haggetts Pond
Great Lawrence SD, N. Andover	MA0100447	02/26/98	52	2ndry	CSO/IPP	13:1	#001 treatment plant effluent to Merrimack River
Haverhill WPCF, Haverhill	MA0101621	1997	18.1	2ndry	CSO/IPP	35:1	#001 treatment plant effluent to Merrimack and Little Rivers
Lowell Reg. WW Utility, Lowell	MA0100633	08/14/97	32	2ndry	CSO/IPP	20:1	#035 treatment plant effluent to Merrimack River and Concord River
Merrimack WWTF, Merrimack	MA0101150	08/14/97	0.45	2ndry		Tidal	#001 treated sanitary and industrial wastewater to Merrimack River
Merrimack WTF, Merrimack	MAG640030	10/10/01	0.11	WTP			#001 filter backwash to unnamed swamp bordering Lake Attitash
Town of Methuen	MA0102971						permit inactive 4/27/99
Newburyport WPCF, Newburyport	MA0101427	09/17/98	3.4	2ndry	IPP	Tidal	to Merrimack River
Salisbury WWTF, Salisbury	MA0102873	10/02/97	1.3	AWT	Fecal = 50	Tidal	#001 effluent to Merrimack River
Amesbury WTP, Amesbury	MA0102822	1985					#001 and #002 to Powwow River
Lowell WTP, Lowell	MA0005452						
Salisbury WTP, Salisbury	MA0025038	1975					sewer discharge to Blacks Rock Creek
water treatment plants							
Newburyport WTP, Newburyport	MAG640018	8/29/01	0.171	WTP			to Merrimack River
Tewksbury WTP, Tewksbury	MAG640036	6/27/96		WTP			to Merrimack River
Spectacle Pond WTF, Littleton	MAG640002	10/27/95		WTP			to Spectacle Pond

2ndry = secondary treatment
AWT = advanced waste treatment
CSO = combined sewer overflows
IPP = industrial pretreatment program
* 7Q10 value at Lowell USGS gage is 941 cfs; dilution based upon this gage reading
WTP = water treatment plant
[Note: North Andover applied for an NPDES permit (MA0103217) in 1990 to discharge emergency overflow to Lake Cochichewick.]

Table D2. Merrimack River Basin Industrial Treatment Plants. [Note: All general NPDES permits (MAG######) have a flow limit of 1.0 MGD. Volumes in the permitted flow (MGD) column for these facilities were taken from their NPDES general permit applications.]

Permitee	NPDES #	Issuance	Flow (MGD)	Types of Discharge	Receiving Water
AEP Industries, North Andover	MA0035432	9/30/97		#001 contact, nccw, and stormwater	ceased operations 3/31/1999 to Merrimack River
Boott Hydropower, Eldred L. Hydroelectric, Lowell	MAG250163	9/26/00	0.6	nccw	to Merrimack River
Boott Hydropower, Hamilton Power Station, Lowell	MAG250950	9/26/00	0.00144	nccw	to Merrimack River (Hamilton Canal)
Boott Hydropower, John Street Power Station, Lowell	MAG250949	9/26/00	0.006	nccw	Merrimack River (Merrimack Canal)
Boott Hydropower, Lawrence Hydroelectric, Lawrence	MAG250948	09/26/00	0.9	nccw	to Merrimack River
Browning-Ferris Industries, Inc	MA0030066	9/26/97		treated storm water runoff from their refuse hauling truck refueling, cleaning and storage area via six outfalls (# 001, 002, 003, 004, 006, and 007)	to Deep Brook
Courier Westford, Inc. Westford	MAG250724	5/1/97		nccw	to Stony Brook
Ferraz Shawmut Inc. (formerly Gould Electronics), Newburyport	MA0000281	9/18/97	0.06	#001 treated process and nccw	to Merrimack River
Ferrous Technologies, Inc, Lawrence	MAG250015	2/6/98	0.015	nccw	to canal along Merrimack River
Fletcher Granite Co., Westford	MA0020231	09/30/97		#001 overflow water from supply pond, #003 0.05 MGD from the cutting mill (wastewater contains fine stone dust) into a settling lagoon that overflows	to Gilson Brook to Stony Brook
Gencorp, Inc, Lawrence	MA0003824	7/23/92		site water from their property	to Spicket River
Haverhill Paperboard Corp., Haverhill	MAG250961	09/08/00	2.6	nccw	to Merrimack River
Lowell Cogeneration LTD, Lowell	MA0031071	08/11/87	0.115	#001combined cooling tower blowdown, boiler blowdown, and demineralizer water #002 stormwater runoff, building floor drains, equipment drains and intermittent boiler blowdown	to Pawtucket Canal to Merrimack River
Lowell National Historic Park, Lowell	MAG250732	11/21/00	0.36	nccw	Merrimack River (Eastern Canal)
Lucent Technologies, Inc., Haverhill	MA0001261	03/92	001A - 1.3 001B - 0.3 001C - 0.11 001D - 0.4 001E – 360 (GPM)	001A - treated wastewater from electroplating 001B -treated sanitary wastewater,001C nccw, ultrasonic cleaning water and well water used for backwash, 001D deionized water, 001E treated (remediation) ground water	to Merrimack River
Mill Pond Ground Water Intercept System, Groveland	MA0102661	04/11/83	#001 (0.5), #002 (0.35)	ground water remediation #001 and #002	Johnson Creek and Brindle Brook
Newark Atlantic Paperboard, Lawrence	MAG250813	6/22/01	0.215	nccw	to Merrimack River
Sweetheart Cup Company, North Andover	MAG250012	04/01	0.015 MGD	nccw	unnamed tributary to Merrimack River
Veryfine Products, Inc., Littleton	MA0004936	03/22/00	0.75	#001 effluent	to Reedy Meadow Brook
Westford Anodizing, Graniteville	MA0024414	09/90	0.03	#001 treated process wastewater	To Stony Brook

ccw = contact cooling water
nccw = non-contact cooling water

Table D3. List of WMA registered and permitted average annual water withdrawals in the Merrimack River Basin (LeVangie, D. 2001. Water Management Act Database. Massachussetts Department of Environmental Protection, Bureau of Resource Protection, Database Manager. Boston, MA.).

Permit	Registration	PWSID	System Name	Registered Volume (MGD)	20 Year Permitted Volume (MGD)	Source	G or S	Well/Source Name	Withdrawal location
9P221303701			Cisco Development Partners-NEDC,LLC		0.14		G	BW #3	Boxborough
9P221303701			Cisco Development Partners-NEDC,LLC		0.14		G	BW #6	Boxborough
9P221303701			Cisco Development Partners-NEDC,LLC		0.14		G	BW #4	Boxborough
9P221303701			Cisco Development Partners-NEDC,LLC		0.14		G	BW#2	Boxborough
9P221303701			Cisco Development Partners-NEDC,LLC		0.14		G	BW #1	Boxborough
9P221303701			Cisco Development Partners-NEDC,LLC		0.14		G	BW #5	Boxborough
9P231303801			Far Corners Farm Golf Course, Inc.*		0.23		S	Unnamed Pond	Boxford
9P231303801			Far Corners Farm Golf Course, Inc.*		0.23	3038012-02G	G	Well #5 (Potable)	Boxford
9P231303801			Far Corners Farm Golf Course, Inc.*		0.23	3038012-01G	G	Well #4 (Potable)	Boxford
9P231303801			Far Corners Farm Golf Course, Inc.*		0.23		G	Irrigation Well #2	Boxford
9P231303801			Far Corners Farm Golf Course, Inc.*		0.23		G	Irrigation Well #3	Boxford
9P231303801			Far Corners Farm Golf Course, Inc.*		0.23		G	Irrigation Well #1	Boxford
9P31314901			Malden Mills Industries, Inc.		3.33		S	Stevens Pond	Lawrence
9P31329501		3295000	Tewksbury Water Department		3.17	295-01s	S	Merrimack Riv. Trtmt. Plt	Tewksbury
9P231332401		3324000	West Newbury Water Department		0.16	324-01G	G	Wellfield #1	West Newbury
9P31316001			Western Avenue Dyers, LP		1.93		S	Pawtucket Canal	Lowell
	21301901	2019000	Ayer DPW-Water Division	0.66	0	019-04G	G	Spectacle Pond Well #4	Ayer
	21301901	2019000	Ayer DPW-Water Division	0.66	0	019-03G	G	Spectacle Pond Well #3	Ayer
9P21311501	21311501	2115000	Groton Water Department	0.22	0.33	115-03G	G	Whitney Well	Groton
9P21311501	21311501	2115000	Groton Water Department	0.22	0.33	115-01G	G	Shattuck Well	Groton
9P21311501	21311501	2115000	Groton Water Department	0.22	0.33		G	Baddacook Well	Groton
9P21315801	21315801		Veryfine Products, Inc.	0.22	0.22		G	Process Well #2	Littleton
9P21315801	21315801		Veryfine Products, Inc.	0.22	0.22		G	Process Well #1	Littleton

*indicates permitted withdrawal for less than 365 days, ** indicates registered withdrawal for less than 365 days, G – ground water, S – surface water

Table D3. Continued. List of WMA registered and permitted average annual water withdrawals in the Merrimack River Basin (LeVangie 2001).

Permit	Registration	PWSID	System Name	Registered Volume (MGD)	20 Year Permitted Volume (MGD)	Source	G or S	Well/Source Name	Withdrawal location
	21315802		Aggregate Materials Corporation	1.58	0		S	Settling Pond-Aggregate	Littleton
	21315802		Aggregate Materials Corporation	1.58	0		G	Well 6-LoneStar/San Vel	Littleton
	21315802		Aggregate Materials Corporation	1.58	0		G	Well 5-Lone Star/San Vel	Littleton
	21315802		Aggregate Materials Corporation	1.58	0		G	Well 4-Lone Star/San Vel	Littleton
	21315802		Aggregate Materials Corporation	1.58	0		S	Settling Plant-Crusher	Littleton
	21315802		Aggregate Materials Corporation	1.58	0		G	Well 7-Lone Star/San Vel	Littleton
	21315802		Aggregate Materials Corporation	1.58	0		G	Well 3-Lone Star/San Vel	Littleton
9P21315802	21315803	2158000	Littleton Water Department	0.84	0.63	158-01G	G	Tubular wellfield	Littleton
9P21315802	21315803	2158000	Littleton Water Department	0.84	0.63	158-02G	G	Gravel Packed Well #1	Littleton
9P21315802	21315803	2158000	Littleton Water Department	0.84	0.63	158-04G	G	Gravel Packed Well #5	Littleton
9P21315802	21315803	2158000	Littleton Water Department	0.84	0.63	158-03G	G	Gravel Packed Well #2	Littleton
	21330101		Vesper Country Club	0.23	0		G	Well #2	Tyngsborough
	21330101		Vesper Country Club	0.23	0		S	River Intake	Tyngsborough
	21330101		Vesper Country Club	0.23	0		G	Well #1	Tyngsborough
	21330101		Vesper Country Club	0.23	0		G	Well #3	Tyngsborough
9P21333001	21333001	2330000	Westford Water Department	1.18	0.69	330-06G	G	Howard Road Well	Westford
9P21333001	21333001	2330000	Westford Water Department	1.18	0.69	330-02G	G	Nutting Road Well	Westford
9P21333001	21333001	2330000	Westford Water Department	1.18	0.69	330-04G	G	Country Road Well	Westford
9P21333001	21333001	2330000	Westford Water Department	1.18	0.69	330-01G	G	Forge Village Well #1	Westford
9P21333001	21333001	2330000	Westford Water Department	1.18	0.69		G	Fletcher Well	Westford
9P21333001	21333001	2330000	Westford Water Department	1.18	0.69	330-03G	G	Depot Road Well	Westford
9P21333001	21333001	2330000	Westford Water Department	1.18	0.69	330-05G	G	Forge Village Well #2	Westford
9P21333001	21333001	2330000	Westford Water Department	1.18	0.69	330-07G	G	Cote Well	Westford
	31300701	3007000	Amesbury Water Treatment Facility	1.23	0	007-01G	G	Well #1	Amesbury
	31300701	3007000	Amesbury Water Treatment Facility	1.23	0	007-02G	G	Well #2	Amesbury
	31300701	3007000	Amesbury Water Treatment Facility	1.23	0	007-01S	S	Powwow River	Amesbury
9P31300901	31300901	3009000	Andover Water Treatment	4.56	3.95	009-01S	S	Haggetts Pond	Andover
9P31300901	31300901	3009000	Andover Water Treatment	4.56	3.95	009-02S	S	Merrimack R. at Fish Bk.	Andover

*indicates permitted withdrawal for less than 365 days, ** indicates registered withdrawal for less than 365 days, G – ground water, S – surface water

Table D3. Continued. List of WMA registered and permitted average annual water withdrawals in the Merrimack River Basin (LeVangie 2001).

Permit	Registration	PWSID	System Name	Registered Volume (MGD)	20 Year Permitted Volume (MGD)	Source	G or S	Well/Source Name	Withdrawal location
	31303801		Stanwood Morss**	0.11	0		S	Surface Water	Boxford
	31303801		Stanwood Morss**	0.11	0		S	Surface Water	Boxford
	31303801		Stanwood Morss**	0.11	0		S	Surface Water	Boxford
	31303801		Stanwood Morss**	0.11	0		G	Well	Boxford
	31305601		Laughton Garden Center, Inc.**	0.07	0		G	WELL #2	North Chelmsford
	31305601		Laughton Garden Center, Inc.**	0.07	0		G	WELL #1	North Chelmsford
	31305601		Laughton Garden Center, Inc.**	0.07	0		S	Irrigation Pond	Westford
	31305602	3056002	North Chelmsford Water District	0.94	0	056A03G	G	Gravel Pack Well #3	North Chelmsford
	31305602	3056002	North Chelmsford Water District	0.94	0	056-04G	G	Gravel Packed Well #4	North Chelmsford
	31305602	3056002	North Chelmsford Water District	0.94	0	056A02G	G	Gravel Pack Well #2	North Chelmsford
	31305602	3056002	North Chelmsford Water District	0.94	0	056A01G	G	Gravel Pack Well #1	North Chelmsford
	31305603	3056000	Chelmsford Water District	1.73	0	056-03G	S	Jordan Road	Chelmsford
	31305603	3056000	Chelmsford Water District	1.73	0	056-12G	G	Meadowbrook Rd Well #1	Chelmsford
	31305603	3056000	Chelmsford Water District	1.73	0	056-14G	G	Smith Street Well #2	Chelmsford
	31305603	3056000	Chelmsford Water District	1.73	0	056-08G	G	Crooked Spring Well 2	Chelmsford
	31305603	3056000	Chelmsford Water District	1.73	0	056-06G	G	Crooked Spring Well 1	Chelmsford
	31305603	3056000	Chelmsford Water District	1.73	0	056-10G	G	Meadowbrook Rd Well #2	Chelmsford
	31305603	3056000	Chelmsford Water District	1.73	0	056-07G	G	Smith Street Well #1	Chelmsford
	31307901		P J Keating Company	0.58	0		S	Merrimack Intake	Dracut
9P231307901	31307902	3079000	Dracut Water District	0.79	1.37	079-03G	G	New Boston Well #1	Dracut
9P231307901	31307902	3079000	Dracut Water District	0.79	1.37	079-02G	G	New Boston Well #2	Dracut
9P231307901	31307902	3079000	Dracut Water District	0.79	1.37	079-04G	G	Tyngsborough (Frost Road) Well Field	Tyngsborough
9P231307901	31307902	3079000	Dracut Water District	0.79	1.37	079-05G	G	Tyngsborough (Frost Road) Well Field	Tyngsborough
9P231307901	31307902	3079000	Dracut Water District	0.79	1.37	079-06G	G	Tyngsborough (Frost Road) Well Field	Tyngsborough
9P231307901	31307902	3079000	Dracut Water District	0.79	1.37	079-07G	G	Tyngsborough (Frost Road) Well Field	Tyngsborough
9P231307901	31307902	3079000	Dracut Water District	0.79	1.37	079-08G	G	Tyngsborough (Frost Road) Well Field	Tyngsborough

*indicates permitted withdrawal for less than 365 days, ** indicates registered withdrawal for less than 365 days, G – ground water, S – surface water

Table D3. Continued. List of WMA registered and permitted average annual water withdrawals in the Merrimack River Basin (LeVangie 2001).

Permit	Registration	PWSID	System Name	Registered Volume (MGD)	20 Year Permitted Volume (MGD)	Source	G or S	Well/Source Name	Withdrawal location
9P231311601	31311601	3116000	Groveland Water Department	0.41	0	3116000-01G	G	Well #1	Groveland
9P231311601	31311601	3116000	Groveland Water Department	0.41	0	3116000-04G	G	Well #4	Groveland
9P231311601	31311601	3116000	Groveland Water Department	0.41	0		G	GPW #3	Groveland
	31312802	3128000	Haverhill Water Department	6.06	0	128-03S	S	Crystal Lake	Haverhill
	31312802	3128000	Haverhill Water Department	6.06	0	128-01S	S	Kenoza Lake	Haverhill
	31312802	3128000	Haverhill Water Department	6.06	0	128-05S	S	Millvale Reservoir	Haverhill
	31312803		Haverhill Paperboard Corporation	2.23	0		S	Merrimack River	Haverhill
	31312804		Bradford Country Club**	0.06	0		G	Well #4	Haverhill
	31312804		Bradford Country Club**	0.06	0		S	Peabody Brook	Haverhill
	31312805		Spring Hill Farm Dairy Inc.	0.06	0		S	river intake	Haverhill
	31314901		Newark Atlantic Paperboard Corp	0.56	0		S	North Canal Intake	Lawrence
	31314902	3149000	Lawrence Water Works	9.46	0	149-01S	S	Merrimack River	Lawrence
	31314903		Merrimack Paper Company, Inc.	0.55	0		S	Merrimack River	Lawrence
	31314903		Merrimack Paper Company, Inc.	0.55	0		S	Essex Co. South Canal	Lawrence
	31314904		Ogden Martin Systems of Haverhill	10.25	0		S	Stevens Pond	Lawrence
9P231316003	31316001	3160000	Lowell Water Treatment Facility	13.84	5.18		S	Merrimack River	Lowell
	31318001	3180000	Merrimack Water Department	0.36	0	180-01G	G	East Main Street Well	Merrimack
	31318001	3180000	Merrimack Water Department	0.36	0	180-02G	G	Sargent Wellfield	Merrimack
	31318101	3181000	Methuen Water Department	4.59	0	01S	S	Merrimack River	Methuen
	31318102		Hickory Hill Golf Course, Inc.**	0.07	0		S	River Intake	Methuen
	31318102		Hickory Hill Golf Course, Inc.**	0.07	0		G	Well #1	Methuen
9P31320601	31320601	3206000	Newburyport Water Department	2.2	0.29	206-02G	G	Well #2	Newburyport
9P31320601	31320601	3206000	Newburyport Water Department	2.2	0.29	206-01S	S	Artichoke Reservoir	Newburyport
9P31320601	31320601	3206000	Newburyport Water Department	2.2	0.29	206-01G	G	Well #1	Newburyport
9P31320601	31320601	3206000	Newburyport Water Department	2.2	0.29		S	Bartlett Spring Pond	Newburyport
9P31320601	31320601	3206000	Newburyport Water Department	2.2	0.29	No ID#	S	Indian Hill Reservoir	West Newbury
	31321001	3210000	North Andover Water Department	2.66	0	210-02S	S	Lake Cochichewick	North Andover

*indicates permitted withdrawal for less than 365 days, ** indicates registered withdrawal for less than 365 days, G – ground water, S – surface water

Table D3. Continued. List of WMA registered and permitted average annual water withdrawals in the Merrimack River Basin (LeVangie 2001).

Permit	Registration	PWSID	System Name	Registered Volume (MGD)	20 Year Permitted Volume (MGD)	Source	G or S	Well/Source Name	Withdrawal location
9P31321001	31321002		Lucent Technologies, Inc.	0.38	0.29		G	Well #5	North Andover
9P31321001	31321002		Lucent Technologies, Inc.	0.38	0.29		G	Well #4	North Andover
9P31321001	31321002		Lucent Technologies, Inc.	0.38	0.29		G	Well #2	North Andover
9P31321001	31321002		Lucent Technologies, Inc.	0.38	0.29		G	Well #1	North Andover
9P31321001	31321002		Lucent Technologies, Inc.	0.38	0.29		G	Well #3	North Andover
	31325901	3259000	Salisbury Water Supply Company	0.25	0	259-06G	G	Well #7	Salisbury

*indicates permitted withdrawal for less than 365 days, ** indicates registered withdrawal for less than 365 days, G – ground water, S – surface water

APPENDIX E - DMF SHELLFISH DATA, MERRIMACK RIVER BASIN

It is the mission of the Division of Marine Fisheries (DMF) to manage, develop, and protect the Commonwealth's renewable living marine resources to provide the greatest public benefit. DMF fosters protection of the marine environment by cooperating with other state and federal agencies on pollution abatement, coastal wetlands protection and other programs concerning coastal waters and marine life. DMF monitors coastal contaminant levels in fish and shellfish, operates a shellfish depuration facility, and evaluates the impacts of coastal development on marine fish and their habitats. DMF provides assistance to local shellfish officers on matters affecting the management of shellfish, and provides expertise on anadromous fish and construction assistance on fishways. Other DMF programs assist commercial and recreational fishermen and educate the public on marine resource issues and values.

The DMF Shellfish Management Program manages shellfish growing areas in compliance with the National Shellfish Sanitation Program (NSSP). The NSSP is a federal/state cooperative program recognized by the U.S. Food and Drug Administration (FDA) and the Interstate Shellfish Sanitation Conference (ISSC). One goal of this program is the sanitary control of shellfish harvested and sold for human consumption. Growing areas are managed with respect to shellfish harvest for direct human consumption, and comprise at least one or more classification areas. The classification areas are the management units, and range from being approved to prohibited (six different classification types in all) with respect to shellfish harvest (Table E1).

Table E1. DMF Shellfish Management Program Managed Shellfish Growing Area Classifications.

Classification Type	Definition
Approved	Means a classification used to identify a growing area where harvest for direct marketing is allowed. The area is shown to be free of bacterial contaminants under a variety of climatological and hydrographical situations (i.e. assumed adverse pollution conditions). Average fecal coliform concentrations may not exceed 14 FC/100ml H_20 and no more than 10% of the samples may not exceed a value of 28 FC/100ml H_20. Open for harvest of shellfish for direct human consumption.
Conditionally Approved	Means a classification used to identify a growing which meets the criteria for the approved classification except under certain conditions described in a management plan. This classification category may be assigned for growing areas subject to intermittent and predictable microbiological contamination that may be present due to operation of a sewage treatment plant, rainfall, and/or season. Use of the conditionally approved classification is strictly a voluntary option due to the considerable investment in time and resources demanded by the NSSP to establish and maintain the classification. The returns are worth the effort and costs only for growing areas with abundant shellfish assets. During the time the area is approved, it is open for harvest of shellfish for direct human consumption subject to local rules and state regulations.
Conditionally Restricted	Means a classification used to identify a growing area that meets the criteria for the restricted classification except under certain conditions described in a management plan. During the time the area is restricted, it is only open for the harvest of shellfish with depuration subject to local rules and state regulations.

Table E1. Continued. DMF Shellfish Management Program Managed Shellfish Growing Area Classifications.

Classification Type	Definition
Restricted	Means a classification used to identify where harvesting shall be by special license and the shellstock, following harvest, is subject to a suitable and effective treatment process through relaying or depuration. Restricted growing areas are mildly or moderately contaminated only with bacteria. Average fecal coliform concentrations may not exceed 88 FC/100ml H_20 and no more than 10% of the samples not may exceed a value of 173 FC/100ml H_20. Open for harvest of shellfish with depuration subject to local rules and state regulations for the relay of shellfish.
Management Closure	Closed for the harvest of shellfish. Not enough testing has been done in the area to determine whether it is fit for shellfish harvest or not.
Prohibited	Means a classification used to identify a growing area where the harvest of shellstock is not permitted. Growing area waters are so badly contaminated that no reasonable amount of treatment will make the shellfish safe for human consumption. Growing areas must also be classified as Prohibited if there is no or insufficient information available to make a classification decision. Closed for the harvest of shellfish.

Classification area codes and town names identify each DMF shellfish area. Table E2 is a summary of the DMF shellfish classification area codes and their classification type for the Merrimack River Basin as of October 2000. Out of the 2948.402 acres of shellfish growing areas in the Merrimack River Basin, 179.403 acres were approved by DMF for shellfishing, while a total of 2,768.999 acres, were prohibited.

Table E2. DMF - Shellfish Project Classification Area Information as of October 2000 .

Town	Classification Area Code	Classification Type	Area (acres)
Amesbury	N2.0	Prohibited	37.285
Newbury	N2.0	Prohibited	194.671
Newbury	N3.0	Approved	163.992
Newburyport	N2.0	Prohibited	1401.925
Newburyport	N3.0	Approved	15.411
Salisbury	N1.0	Prohibited	116.703
Salisbury	N2.0	Prohibited	1018.415

The water quality evaluation is part of process known as the Sanitary Survey by which a classification is assigned. Shellfish species, habitat location, relative abundance and related fisheries must be documented. A shoreline survey is conducted to identify pollution sources and evaluate potential impacts. Concomitantly, an understanding of hydrographic characteristics that may influence contaminant distribution and removal over the growing area. Supplementary analysis may be required for naturally occurring pathogens (i.e. Vibrio spp.), marine biotoxins (i.e. Paralytic Shellfish Poisoning) as well as hazardous wastes in growing areas with a known history of contamination by these harmful substances.

Sanitary surveys are repeated at least every twelve years for growing areas classified other than Prohibited. Survey information is kept current as well as updated through annual and triennial reports and classifications maintained with extensive monitoring. A growing area classification may be

downgraded and management plans amended based on the findings of annual and triennial reviews. Classification upgrades can only be made based on the findings of a fully sanitary survey.

APPENDIX F - DEP GRANT AND LOAN PROGRAMS

Excerpted from DEP/DWM World Wide Web site http://www.state.ma.us/dep/brp/wm/wmpubs.htm#other. *'Grant and Loan Programs - Opportunities for Watershed Planning and Implementation'* and projects specific to the Merrimack River Basin.

104(b)(3) WETLANDS AND WATER QUALITY GRANT PROGRAM

This Grant Program is authorized under Wetlands and Clean Water Act Section 104(b)(3) of the federal Clean Water Act. The Water Quality proposals received by DEP under this National Environmental Performance Partnership Agreement (NEPPA) with the U.S. Environmental Protection Agency is a results oriented approach that will focus attention on environmental protection goals and the efforts to achieve them. The goals of the NEPPA are to: 1) achieve clean air, 2) achieve clean water, 3) protect wetlands, 4) reduce waste generation, and 5) clean up waste sites.

- 93-05/104- *Microbiological Quality of the Merrimack River.* Microbiological contamination of the Merrimack River associated with municipal wastewater effluent discharges and combined sewer overflows is a concern in this watershed. This research project will help to answer this question and to study the impact of seasonal disinfection or nondisinfection of wastewater effluents on microbiological water quality in the river. (Microbiological data is presented in Appendix G of this report.)
- 98-04/104 *Prioritizing Stormwater Enforcement Efforts; A Multi-Watershed Study.* Stormwater is believed to be the most significant cause of water quality standard violations. In this study, stormwater will be sampled and analyzed for Fecal coliform and total coliform as well as four other indicators (E.coli, enterococci, clostridium perfringenes, and coliphages) in three watersheds; Charles, Merrimack, and Neponset. The four indicators will be used to confirm that the source of high fecal coliform levels is not plant or soil related.

319 NONPOINT SOURCE GRANT PROGRAM

This grant program is authorized under Section 319 of the CWA for implementation projects that address the prevention, control, and abatement of nonpoint source (NPS) pollution. In order to be considered eligible for funding projects must: implement measures that address the prevention, control, and abatement of NPS pollution; target the major source(s) of nonpoint source pollution within a watershed/subwatershed; have a 40 percent non-federal match of the total project cost (match funds must meet the same eligibility criteria as the federal funds); contain an appropriate method for evaluating the project results; address activities that are identified in the Massachusetts NPS Management Program Plan.

- 96-05/319 *Spicket River Watershed Revitalization.* The goal of this project is to use the watershed approach to decrease non-point in an ultra-urban area. An extensive cleanup, education and outreach program will be conducted by a variety of public and private groups. In addition, the project will demonstrate an innovative best management (BMP) for use in ultra-urban areas.
- 01-20/319 *Lake Attitash Stormwater Treatment Program.* The project will design and implement stormwater treatment devices at three stormwater outfalls in the Lake Shore Drive drainage area that directly discharges into the lake. In addition, the project will include pre- and post-implementation water quality monitoring, and the prioritization of additional storm water discharges for treatment.

MASSACHSUETTS WATERSHED INITIATIVE PROJECT

- 99-04/MWI *Implementation of Municipal and Business Outreach Strategy.* This project will continue work begun in 1998 to reach out to the municipalities and to business in the Merrimack River Basin and develop an awareness and involvement by building partnerships.

SOURCE WATER AND TECHNICAL ASSISTANCE/LAND MANAGEMENT GRANT PROGRAM

The Source Water Protection Technical Assistance/Land Management Grant Program provides funds to*third party* technical assistance organizations that assist public water suppliers in protecting local and regional ground and surface drinking water supplies.

- 99-03/SWT *Lake Cochichewick Source Water Protection Project.* This project will prioritize Lake Cochichewick watershed lands for acquisition, protection and control; improve municipal stormwater

management; enhance local emergency response to chemical spills; and, educate watershed residents, business, and other about BMPs to protect the lake's water quality from further degradation.

- 99-12/SWT *Haverhill Watershed Management Plan Implementation.* This project will assist with implementation of Haverhill's new Watershed Protection Plan. Implementation will incorporate a recent analysis of current and potential threats to the water supply.
- 00-01/SWT *Lake Cochichewick Source Water Protection Project-Phase II.* This project will develop a comprehensive Hazardous Materials Response Plan for the Lake Cochichewick watershed. The Lake is bordered by an airport and several busy roads, leaving the town's water supply vulnerable to pollution from accidental spills. An effective response plan will significantly improve the Town of North Andover's capability to prepare for and respond to emergencies in a timely and coordinated manner.
- 00-02/SWT *Powow River Source Water Protection Project.* This project will develop a comprehensive Surface Water Supply Protection Plan for the Powwow River Watershed; educate residents, public officials, stakeholders; update the Emergency Response Plan; conduct two emergency drills; establish a multi-town committee; and prioritize watershed land for acquisition or preservation.
- 00-08/SWT *Millvale Reservoir Source Water Protection Project.* This project will develop an Emergency Response Plan, a Forest Management Plan for the Millvale Reservoir area, a septic system regulation ready for local adoption, a multi-town cooperative agreement, and a Land Management Manual for the City of Haverhill's Millvale watershed. The Millvale Reservoir supplies two-thirds of the City's drinking water needs.

WELLHEAD PROTECTION GRANT PROGRAM

The Wellhead Protection Grant Program provides funds to assist public water suppliers in addressing wellhead protection through local projects and education.

- 00-02/WHP *Ayer Wellhead Protection Project.* This project will develop a comprehensive Wellhead Protection Plan for the Town of Ayer. The project will also identify and map the existing and potential threats to the Grove Pond and Spectacle Pond Wells, create an industrial hazardous materials map, install wellhead protection signs at two well sites, replace gates to protect the Grove Pond wells, and update the town's emergency water supply plan
- 00-08/WHP *West Newbury Wellhead Protection Project.* This project will construct a new storage facility for water treatment chemicals currently located in the Zone 1 of the Town of West Newbury's wellfield. The present system is inadequate, unsafe for employees, and a potential threat to Artichoke Reservoir, within the Zone 1. KOH, loaded in 55 gallon barrels, currently is brought into an undersized storage building by hand. A rupture could release chemicals directly into the reservoir. Relocating and upgrading the storage facility will ensure that liquid chemicals cannot contaminate the nearby wells in the event of a spill.

COASTAL POLLUTANT REMEDIATION PROGRAM

The Coastal Pollutant Remediation Program provides funds to help identify and clean up sources of road runoff and other stormwater pollution to important coastal areas, such as swimming beaches and shellfish beds. Massachusetts Coastal Zone Management administers the funds.

- In 1998 the Town of Salisbury was awarded $62,600 for the installation of a stormwater treatment system to help improve water quality in the Merrimack River

CLEAN WATER STATE REVOLVING LOAN FUND (SRF) PROGRAM

LOWELL WWTF Wet Weather Flow Modification

The project consists of improvements to existing processes and physical equipment to increase the capacity and reliability of wet weather treatment at the WWTP, from about 90 mgd to potentially as high as 110 mgd. and will allow the city to maximize the treatment potential at its existing facility, which will ultimately reduce combine sewer overflow discharges to the Merrimack river and its tributaries. The project will take 3 years to complete.

NEWBURYPORT Plum Island WW Improvements

The objective of the project is to construct a wastewater collection system to eliminate subsurface disposal systems from the Plum Island and the inherent pollution of the freshwater lens used for drinking water, local beaches and numerous environmentally sensitive areas throughout the island. The work involves three contracts: Contract 1 would sewer the inhabited portion of Plum Island and transport the wastewater along the Plum Island Turnpike to the Newburyport Wastewater Treatment Plant on Water Street; Contract 2 is for the improvements to the Wastewater Treatment Facility in particular upgrading the aeration capacity of the WWTF; and Contract 3 is to eliminate inflow/infiltration sources to the city's sewer system. The total cost for this three year project is $18,126,000.00.

APPENDIX G – DEP/WES MERRIMACK RIVER MICROBIAL INDICATOR STUDY 1999-2001

As part of the Microbial Indicator Study of the Merrimack River, bacteriological data were collected. The bacteriological data subset of the study data appears in Table G1. All quality control samples for these reported data points meet acceptance criteria. Upon completion of this study in the Fall 2001 a detailed technical project report will be published by the Department.

Table G1. Bacteriological data extracted from the Microbial Indicator Study.

Site	Location	Collection Date	Total Coliforms – MF (CFU/100mL)	Fecal Coliforms (CFU/100mL)	E_ coli – mTEC (CFU/100mL)
Lowell Water Treatment Plant	Merrimack River intake	8/30/1999	NT	55	36
		10/19/1999	NT	150	31
		9/12/2000	NT	5	<5
		4/10/2001	NT	100	2
Lowell Water Treatment Plant	finished water before distribution	8/30/1999	<1	NT	NT
		10/19/1999	<1	NT	NT
		9/12/2000	<1	<5	<5
		4/10/2001	<1	NT	NT
Lowell	Merrimack River downstream CSO, upstream POTW	8/24/1999	NT	1100	215
		10/19/1999	NT	97	56
		9/12/2000	NT	1200	580
		4/11/2001	NT	180	8
Lowell	Merrimack River below POTW	8/11/1999	NT	120	69
		8/24/1999	NT	120	43
		10/19/1999	NT	52	8
		9/12/2000	NT	210	110
		4/11/2001	NT	120	15
Methuen Water Treatment Plant	Merrimack River intake	8/24/1999	NT	36	33
		10/20/1999	NT	180	58
		9/13/2000	NT	420	250
		4/10/2001	NT	23	<1
Methuen Water Treatment Plant	finished water before distribution	8/24/1999	<1	NT	NT
		10/20/1999	<1	NT	NT
		9/13/2000	<1	<5	<5
		4/10/2001	<1	NT	NT
Lawrence Water Treatment Plant	Merrimack River intake	8/24/1999	NT	45	14
		10/20/1999	NT	130	87
		9/14/2000	NT	140	83
		4/10/2001	NT	32	<1
Lawrence Water Treatment Plant	finished water before distribution	8/24/1999	<1	NT	NT
		10/20/1999	<1	NT	NT
		9/14/2000	<1	<5	<5
		4/10/2001	<1	NT	NT

NT - not tested
MF - membrane filter method
mTEC - agar used

Table G1. Continued. Bacteriological data extracted from the Microbial Indicator Study.

Site	Location	Collection Date	Total Coliforms – MF (CFU/100mL)	Fecal Coliforms (CFU/100mL)	E_ coli – MTEC (CFU/100mL)
Lapage Dock Haverhill	Merrimack River downstream Greater Lawrence Sanitary District, upstream Haverhill CSO	8/25/1999	NT	680	42
		10/20/1999	NT	83	42
		9/13/2000	NT	86	81
		4/11/2001	NT	81	4
Fire Station, Haverhill	Merrimack River downstream CSO, upstream POTW	8/25/1999	NT	380	35
		10/20/1999	NT	110	52
		9/13/2000	NT	4300	1200
		4/11/2001	NT	87	5
Groveland	below Bates Bridge	8/25/1999	NT	97	3
		10/20/1999	NT	200	77
		9/13/2000	NT	220	140
		4/11/2001	NT	61	10

NT - not tested
MF - membrane filter method
mTEC - agar used